

HEKIMIAN

Model 3700 Communications Test Systems User's Manual

Model 3700
Communications
Test Systems
User's Manual

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Model 3700
Communications Test Systems
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**MODEL 3700 COMMUNICATIONS TEST SYSTEM
USER'S MANUAL
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This manual consists of a number of individual documents. These documents are listed below, in the order in which they appear in this manual.

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SECTION 1 - INTRODUCTION

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1.1 Purpose of this Manual

This manual documents the information needed to understand and use the Model 3701 VF and Model 3705 PCM/VF Communications Test Systems (CTSs). (The Model 3701 and Model 3705 are equipped for front-panel controlled operation; remotely controlled operation is optional. The Model 3707 is equipped *only* for remotely controlled operation.) Specifically, this manual contains information that:

- Describes the purpose and capabilities of the CTS
- Introduces components used in the units
- Describes how to install, operate, and maintain the units.

NOTE: With the release of Firmware Revision Level D/F16.00, Model 3703 VF Remote units were redesignated Model 3707 units.

1.2 How to Use this Manual

Use the following descriptions to become familiar with the content of each section of this manual.

SECTION 1 - INTRODUCTION describes how to use this manual and lists related documentation. Use this section to become familiar with the content of this manual.

SECTION 2 - EQUIPMENT DESCRIPTIONS provides both physical and functional descriptions of the CTS. This section describes standard CTS configurations and all available options.

SECTION 3 - INSTALLATION describes how to install and initialize the CTS and interface the unit with external equipment.

SECTION 4 - FRONT-PANEL CONTROLLED OPERATION provides general guidelines for operating the CTS using front panel controls.

SECTION 5 - REMOTELY CONTROLLED OPERATION describes how to operate the CTS through a remote test position.

SECTION 6 - MAINTENANCE provides troubleshooting guidelines to localize CTS faults. This section also provides instructions for returning failed equipment for repairs.

MODEL 3700 OPTION .72 EASYTEST EDITOR/RAM BUFFER USER'S MANUAL describes how to create EasyTest procedures using Option .72.

GLOSSARY - The glossary lists abbreviations, acronyms, and specialized terms applicable to Hekimian test, access, and operations support equipment.

1.3 Related Documentation

The following documents contain information related to operating the CTS. To order these documents, contact your area sales representative, or call Hekimian Customer Support at 1-800-321-0780.

REACT 2000 Operations Support System User's Manual.

PN 3200-45 Volume 1 - Testing Your Network

Volume 2 - Reference

PN 3200-46 Volume 3 - Managing Your System.

1.4 Revisions to this Manual

Issue 1, Change 1 replaces Issue 1 of July 1992. Issue 1, Change 1 updates information on the Model 3700 CTS and corrects formatting errors that may have existed in the previous issue of this manual.

1.5 Trademarks

EasyTest is a trademark of Hekimian Laboratories, Inc.

SLC-96 is a trademark of AT&T.

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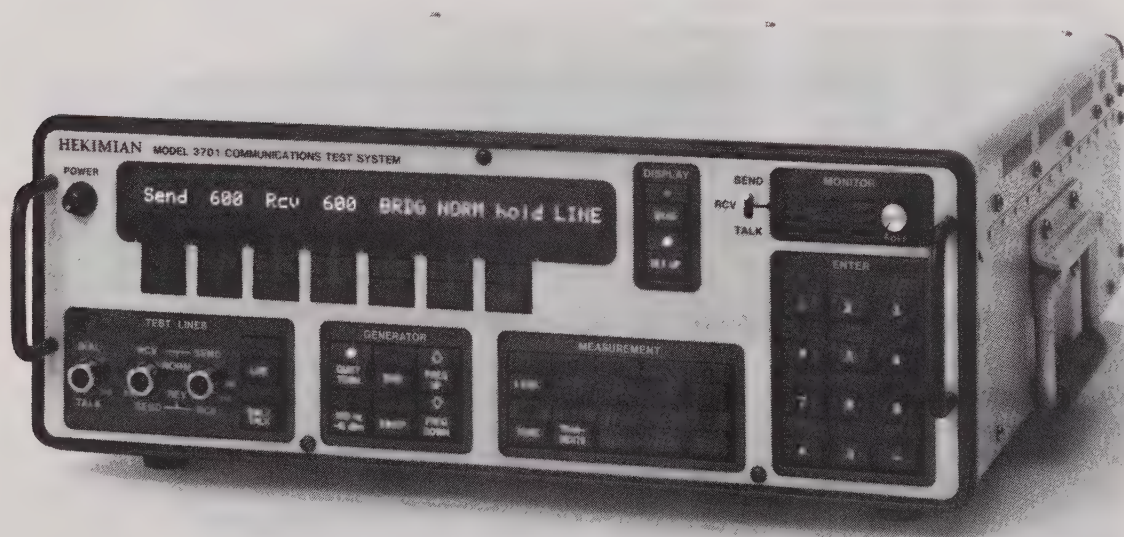
2.1 Equipment Overview

The Model 3701 VF and Model 3705 PCM/VF Communications Test Systems (CTSs) interface directly with the following:

- 2-wire or 4-wire analog circuits
- Superframed, extended superframed, and SLC-96 T1 lines
- Digital Cross-connect System (DCS) digroups.

The CTS performs a wide range of voice-frequency (VF) measurements. These units may also be equipped to perform a full complement of pulse code modulation (PCM) error measurements. Additional features and measurement capabilities are available through plug-in option boards.

The Model 3701 and Model 3705 CTSs, shown in Figures 2-1 and 2-2, can be used as portable or rack-mounted instruments. These units are equipped for front-panel controlled operation; remotely controlled operation is available as an option. During front-panel controlled operation, basic unit and optional measurement parameters, test status, and test results display on a large 40-character display. Seven soft keys under the display allow the user to select from preset values, or enter new values using the front-panel numeric keypad. The Model 3700 CTS, shown in Figure 2-3, is a rack-mounted unit designed *only* for remotely controlled operation. It includes Option .25A-232 Remote Control.



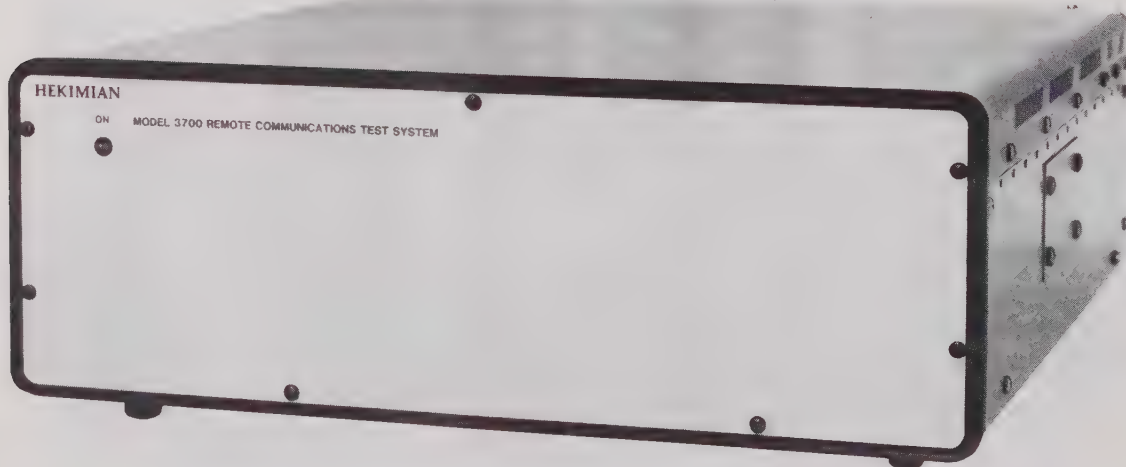
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Figure 2-1. Model 3701 VF Communications Test System



352C

Figure 2-2. Model 3705 PCM/VF Communications Test System



1756A

Figure 2-3. Model 3707 Remote Communications Test System

The CTS basic units incorporate all interface and support circuitry required by plug-in option boards. This includes a 1-minute through 60-minute and continuous timer used for impulse noise and hit/dropout measurements. C-message and 3-kHz flat noise weighting filters are standard. The 15-kHz flat and program weighting filters are available with Option .15.

A multifunction signal generator combines features required for both manual and sweep operation:

- Step tuning of 1, 10, 100 Hz and 1 kHz along with a low-distortion 1004-Hz fixed level, holding tone
- Sweep measurements with three selectable sweep rates
- SF skip, where the send level is keyboard-programmable to 0.1 dB resolution, and pushbuttons are available for both a quiet termination and a loopback tone (2713 Hz)
- A built-in dial/talk feature for dialing and communication on the line under test.

2.1.1 Analog Testing Configurations

2.1.1.1 VF and VF Data Testing Configurations

The following configurations support basic VF and VF data testing:

- Model 3701-18 Basic Portable VF Test System (US), 115/230 Vac power
- Model 3707-15 Basic Remote-Only VF Test System (US), RS-232-C interface, -48 Vdc power
- Model 3701-19 Portable VF Data Test System (US), 115/230 Vac power
- Model 3707-28 Remote-Only VF Data Test System (US), RS-232-C interface, -48 Vdc power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, and return loss measurements. Additional measurements for systems that support data testing include envelope delay, hits/jitter, Peak to Average Ratio (P/AR), and intermodulation distortion. The frequency range for these units is from 40 through 20,100 Hz. These units are also equipped for Dual Tone Multi-Frequency (DTMF), Multi-Frequency (MF), and Dial Pulse (DP) signaling.

2.1.1.2 Wideband VF and Wideband VF Data Testing Configurations

The following configurations support wideband VF and wideband VF data testing:

- Model 3701-21 Portable Wideband VF Test System (US), 115/230 Vac power
- Model 3707-23 Remote-Only Wideband VF Test System (US), RS-232-C interface, -48 Vdc power
- Model 3701-22 Portable Wideband VF Data Test System (US), 115/230 Vac power
- Model 3707-24 Remote-Only Wideband VF Data Test System (US), RS-232-C interface, -48 Vdc power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, and return loss measurements. Additional measurements for systems that support data testing include envelope delay, hits/jitter, P/AR, and intermodulation distortion. These units are equipped with 15-kHz flat, 50 kilobit, and 50-kHz flat noise weighting filters. The frequency range for these units is from 40 through 120,000 Hz. These units are also equipped for DTMF, MF, and DP signaling.

2.1.1.3 VF ISDN/DDS Loop Qualification Configurations

The following configurations support VF ISDN and DDS loop qualification testing:

- Model 3701-20 Portable VF ISDN/DDS Test System (US), 115/230 Vac power
- Model 3707-25 Remote-Only VF ISDN/DDS Test System (US), RS-232-C interface, 115/230 Vac power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, return loss, and VOM/CAP measurements. These units are equipped with 15-kHz flat, 50 kilobit, and 50-kHz flat noise weighting filters. The frequency range for these units is from 40 through 120,000 Hz. These units are also equipped for DTMF, MF, and DP signaling.

2.1.2 Digital Testing Configurations

2.1.2.1 PCM/VF and PCM/VF Data Testing Configurations

The following configurations support PCM/VF and PCM/VF data testing:

- Model 3705-20 Basic Portable PCM/VF Test System (US), 115/230 Vac power
- Model 3707-14 Basic Remote-Only PCM/VF Test System (US), RS-232-C interface, -48 Vdc power
- Model 3705-22 Portable PCM/VF Data Test System (US), 115/230 Vac power
- Model 3707-17 Remote-Only PCM/VF Data Test System (US), RS-232-C interface, -48 Vdc power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, and return loss measurements. Additional measurements for systems that support data testing include envelope delay, hits/jitter, P/AR, and intermodulation distortion. The frequency range for these units is from 40 through 20,100 Hz. These units are also equipped for DTMF, MF, and DP signaling.

2.1.2.2 Wideband PCM/VF and Wideband PCM/VF Data Testing Configurations

The following configurations support wideband PCM/VF and wideband PCM/VF data testing:

- Model 3705-24 Portable Wideband PCM/VF Test System (US), 115/230 Vac power
- Model 3707-18 Remote-Only Wideband PCM/VF Test System (US), RS-232-C interface, -48 Vdc power
- Model 3705-25 Portable Wideband PCM/VF Data Test System (US), 115/230 Vac power
- Model 3707-19 Remote-Only Wideband PCM/VF Data Test System (US), RS-232-C interface, -48 Vdc power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, and return loss measurements. Additional measurements for systems that support data testing include envelope delay, hits/jitter, P/AR, and intermodulation distortion. These units are equipped with 15-kHz flat, 50 kilobit, and 50-kHz flat noise weighting filters. The frequency range for these units is from 40 through

120,000 Hz. These units are also equipped for DTMF, MF, and DP signaling.

2.1.1.3 PCM/VF ISDN/DDS Loop Qualification Configurations

The following configuration supports PCM/VF ISDN and DDS loop qualification testing:

- Model 3705-23 Portable PCM/ISDN/DDS Test System (US), 115/230 Vac power.

These units include test capability for noise, level and frequency, signal-to-noise ratio, three-level impulse noise, return loss, and VOM/CAP measurements. These units are equipped with 15-kHz flat, 50 kilobit, and 50-kHz flat noise weighting filters. The frequency range for these units is from 40 through 120,000 Hz. These units are also equipped for DTMF, MF, and DP signaling.

2.2 Functional Descriptions

This section describes the analog and digital testing capabilities of the CTS. It also describes the dial/talk and macro features of the units.

2.2.1 Analog Testing

The Model 3701 VF and Model 3705 PCM/VF CTSs test analog circuits to IEEE Standard 743/Bell PUB 41009 specifications and CCITT O-series Recommendations. The basic CTS measures 40 Hz through 20 kHz level and frequency, noise, signal-to-noise ratio, three-level impulse noise, and return loss. The analog circuit interface accommodates both 2-wire and 4-wire circuits. Other features include the following:

- Independent selection of send and receive impedances of 135, 600, 900, or 1200 ohms (bridged or terminated receive)
- Send/receive line reversal
- Dual hold circuits
- Internal and external dialing for dial pulse, DTMF, or MF digits
- Optional call progress and signaling
 - Ground-start and loop-start
 - E&M
 - SF (single frequency)
 - Dial pulse, DTMF, or MF digit decoding
 - Call progress detection.

A wide range of additional options are available to expand the analog test capabilities of the CTS.

2.2.2 Digital Testing

The Model 3705 PCM/VF CTS, equipped with Option .64 ESF PCM, interfaces directly to 1.544 Mbps T1 lines or test access digroups of a DCS. This enables the unit to perform a full complement of in-service PCM error measurements. Built-in digital-to-analog (D/A) and analog-to-digital (A/D) converters allow complete analog testing of DS1 signals on a per-channel basis. The CTS measures and detects the following:

- Bipolar violations
- Excessive zeros
- Frame bit errors
- Multiframe bit errors (superframed only)
- CRC errors (ESF only)
- Errored seconds
- No PCM alarms
- Frame alignment alarms
- Remote frame alignment alarms.

The CTS may be configured in any one of three modes to allow monitor and drop-and-insert testing:

- INLIN (in-line) for nonintrusive testing in-service circuits while channels not selected pass through undisturbed
- TRML (terminal) for looped testing of channel banks while idle channel code (01111111) transmits to channels not selected
- DCS for accessing both circuit directions through a DCS test access facility while ports not selected pass through undisturbed.

NOTE: DCS permits daisy-chaining of multiple CTSs on a single DCS test access digroup (TAD).

In the monitor mode, the CTS monitors the voice frequency signal of a selected channel and the status of A and B, or A, B, C, and D robbed-bit signaling or SF tone. In the drop-and-insert mode, the CTS generates a test signal and inserts it into the selected PCM channel. The CTS also detects and generates the following supervisory signaling:

- Channel associated signaling bits or SF supervision in both directions
- Wink detection
- Dial pulsing
- FXO and FXS signaling and control functions.

When equipped with Option .65 T1 Bit Error Ratio, the unit also performs out-of-service bit error ratio tests at both the T1 and channelized levels.

2.2.3 Dial/Talk Capability

Dialing and communication features are included in the CTS. You can monitor either side of a 4-wire circuit, and talk on the send side of the line under test. For 2-wire circuits, the CTS features dual hold and keypad dialing of dial pulse, DTMF, or MF digits. The portable CTS front panel includes a numeric keypad for dialing, a speaker for monitoring and talking on the circuit, and a jack for connecting a handset. Both manual and automatic dialing are available. In automatic dial, up to 99 registers with up to 40 digits may be entered and then dialed with a single key press. Dialing may also be conditioned on wink detection.

2.2.4 Macro Capability

With the EasyTest Editor, the CTS can be configured to accommodate a wide variety of remotely controlled test applications. You can create, edit, and store complex test sequences unique to your requirements. Then, with one command, you can run the stored test sequence. In computer controlled test systems, the EasyTest Editor enables you to download test sequences directly to the CTS.

2.3 Physical Descriptions

The CTS physical characteristics are summarized in Table 2-1. The CTS is available as both a portable unit and as a remotely controlled unit. (The CTS cover contains a storage compartment for the detachable ac power cord.) All operating controls and indicators are mounted on the front panel of the portable units. The rear panel includes a power switch, a power fuse, and connectors for power and line connections.

Table 2-1. CTS Physical Characteristics

CHARACTERISTIC	SPECIFICATION
Dimensions	15.0 in. (38.1 cm) W, 5.25 in. (13.3 cm) H, 18.5 in. (47.0 cm) D
Weight	20.5 lb. (9.3 kg)
Environment	
Operating	+32 through +122 °F (0 to +50 °C) 5 through 95% relative humidity, without condensation
Storage	-40 through +158 °F (-40 to +70 °C) 5 through 90% relative humidity, without condensation

2.3.1 Model 3701 and Model 3705 Front-Panel Descriptions

Front-panel components described in this section are shown in Figure 2-4.

- ① **Monitor Section** controls the monitor and talk/listen controls for dial/talk. The volume control adjusts the listening level and includes an OFF position. The speaker is also used as a microphone for the internal talk capability.
- ② **Display Section** controls the function of the 40-character alphanumeric display. In the MEAS mode, the test status and test results display; in the SET UP mode, measurement parameters display.
- ③ **40-Character Display** selects measurement parameters or displays test status and test results.
- ④ **Soft Keys** select test functions or set up measurement parameters.

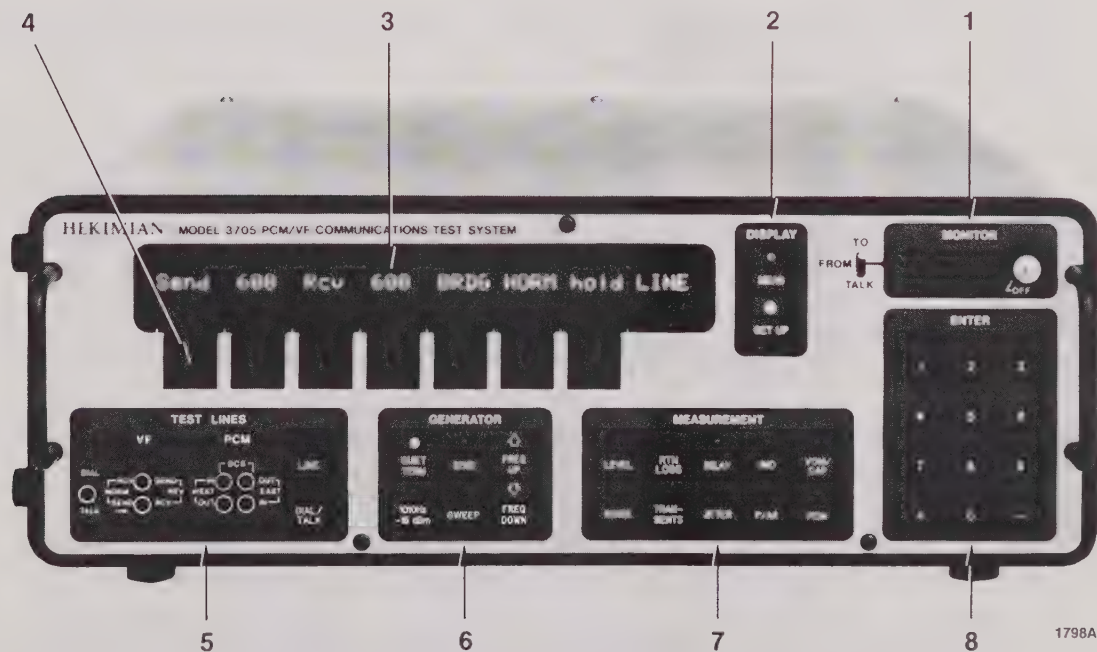


Figure 2-4. Model 3705 Front-Panel Callout

- ⑤ **Test Lines Section** for the Model 3705 contains the VF SEND and RCV bantam jacks, the DIAL/TALK bantam jack, the PCM DCS EAST and WEST IN/OUT bantam jacks, the LINE key for line interface setup, and the DIAL/TALK key for 2-wire dial/talk and 4-wire talk.

NOTE: Rear-panel barrier strip connections are wired to normalling contacts on the corresponding front-panel bantam jacks. Therefore, when plugs are inserted into front-panel jacks, rear-panel barrier strip connections are interrupted.

For the Model 3701, the test lines section contains the VF SEND and RCV 310 jacks, the DIAL/TALK 310 jack, the LINE key for line interface setup, and the DIAL/TALK key for 2-wire dial/talk and 4-wire talk.

- ⑥ **Generator Section** sets up the generator and controls the sweep functions and quiet termination.
- ⑦ **Measurement Section** selects the type of measurement that appears on the display in both SET UP and MEAS modes. The LED lights while the measurement is active.
- ⑧ **Enter Numeric Keypad** enters set-up parameters and numbers for the internal dial capability.

2.3.2 Model 3701 and Model 3705 Rear-Panel Descriptions

Rear-panel components described in this section are shown in Figure 2-5.

- ① **Remote Control Interface Connector** provides for Option .25A-232 Remote Control.
- ② **Facility Data Link Connectors** provide access to receive and send signals on the ESF facility data link. (Model 3705 units with Option .64 ESF PCM only.) The interface is at RS-232-C levels.
- ③ **Remote Control Interface DIP Switch** provides for setup of the remote control option (Option .25A-232) interface parameters.
- ④ **Test Line Connections** are wired to the normalling contacts on the corresponding front-panel jacks of the Model 3705, both PCM and VF. For the Model 3701, the VF RCV and SEND and the Option .07 X-Y Output connectors contact terminals are wired.
- ⑤ **Power Switch** controls primary power to the CTS.

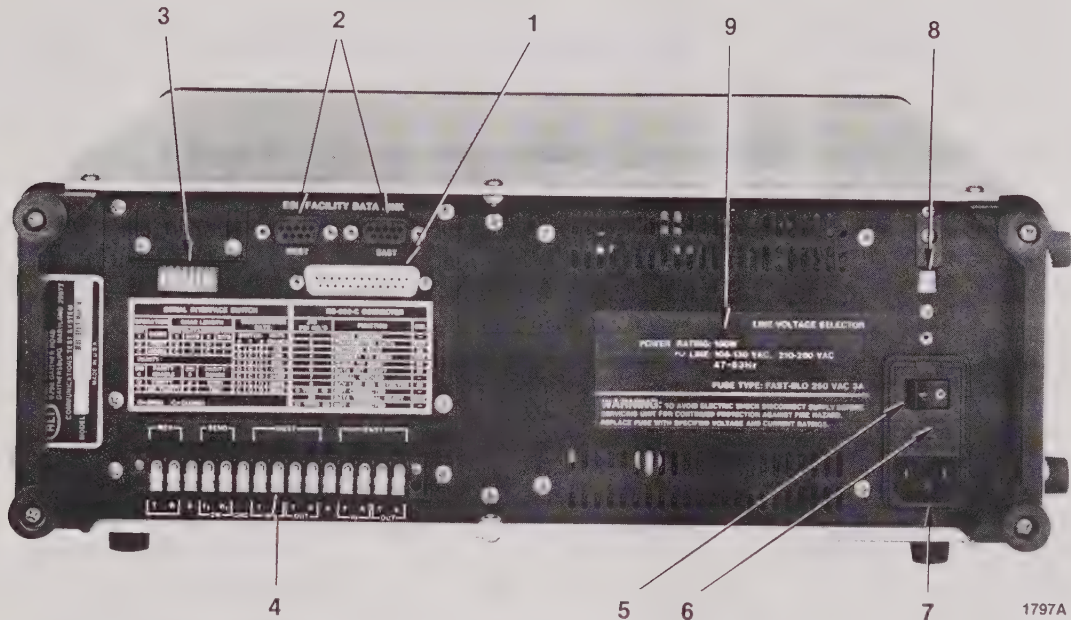


Figure 2-5. Model 3705 Rear-Panel Callout

- ⑥ **Fuse Holder** contains the primary power safety fuse.
 - ⑦ **AC Power Receptacle** provides for a detachable ac power cord. This receptacle is replaced by a barrier strip for Option .06 -48 Vdc Operation or Option .06A -24 Vdc Operation.
 - ⑧ **AC Line Voltage Selector Switch** configures the unit to operate with either 115 or 230 ac line voltage. This switch is not installed with Option .06 or .06A.
 - ⑨ **Power Rating, Fuse Type Information Label** lists the primary power requirements and replacement fuse information.
- (not shown) **Optional Connections Barrier Strip** is provided with Option .35A or .35C Call Progress and Signaling. X-Y Output connections are also provided when Option .07 is included.

2.4 Options

Table 2-2 lists options for the Model 3701 and Model 3705 CTSs. Descriptions of the options are provided in the paragraphs that follow:

Table 2-2. Option List

OPTION	PART NUMBER	CLEI CODE	DESCRIPTION
.01	3700-07 3700-08 3700-09 3700-15		19" Flush Rack Mount 23" Flush Rack Mount 19" Projected Rack Mount 23" Projected Rack Mount
.06 ¹	3700-13		-48 Vdc Operation
.06A ¹	3700-14		-24 Vdc Operation
.07 ¹	3700-10		X-Y Outputs
.08	3705-2025-01 (20 kHz) 3705-2025-02 (120 kHz)	SMTE60EHAA SMTE60JHAA	4Z I/O
.09			20 kHz Basic Unit Operation
.10 ¹			120 kHz Basic Unit Operation
.11			Three-Level Impulse Noise
.12A (.12)	3712A-01 (3712-01)	SMTE60LHAA (TETMEG36AA)	Envelope Delay
.13	3713-01	TETMEH36AA	Hits/Jitter
.14	3714-01	TETMEJ36AA	Intermodulation Distortion
.15 ²	3715-01	TETMEX26AA	15-kHz Flat/Program Noise Weighing Filters
.15B ²	3715B-01	TETMEY26AA	15-kHz Flat/50 kb Noise Weighing Filters
.15C ²	3715C-01	SMTE60MHAA	15-kHz Flat/50 kb/50-kHz Noise Weighing Filters
.16			Return Loss
.18A (.18)	3718A-01 (3718-01)	TETMEE16AA (TETM7006AA)	P/AR
.19	3719-01	TETMER26AA	P/AR and Return Loss
.25A-232	3725A-01	TETMES26AA	Remote Control (RS-232-C)
.30	3730-01	TEPQ571AAA	Intermodulation Distortion and P/AR
.35A	3735A-01	TETN5506AA	Call Progress and Signaling
.35C	3735C-02	SMTE60NHAA	Call Progress and Signaling

Table 2-2. Option List (continued)

OPTION	PART NUMBER	CLEI CODE	DESCRIPTION
.40	3740-01	TETNKR06AA	VOM/CAP
.41 ³	3741-01	TETMET26AA	Master/Slave
.52	3752-01		Responder Interface
.60			DTMF/MF Signaling
.62	3762-01	TETMED36AA	PCM Test/Channel Access
.64	3764-01	TEPQ568AAA	ESF PCM Test/Channel Access
.65 ⁴	3765-01	TEPQ569AAA	T1 Bit Error Ratio
.70 ⁶			EasyTest Interpreter
.71-001			Basic EasyTest Procedure Set
.71-002 ⁵	3771-01	TETMEE36AA	Master/Slave EasyTest Procedure Set
.71-007 ⁵			Enhanced Master/Slave and REACT EasyTest Procedure Set
.71-012 ⁶			REACT 2000 EasyTest Procedure Set
.72 ⁶			EasyTest Editor/RAM Buffer

¹Must be specified when ordering the CTS Basic Unit.
²Option .15,.15B, or.15C can be supplied mounted to Option .30 so that one long option slot is used.
³For remote operation only. Requires Option .25A-232.
⁴Requires Option .64 ESF PCM Test/Channel Access.
⁵Requires Option .41 Master/Slave and Option .25A-232.
⁶Requires Option .25A-232.

NOTE: Some options described in Table 2-2 are now included as standard items. Contact Hekimian Customer Support for availability of specific options.

2.4.1 Basic Unit Options

Option .01 Rack Mounting allows the CTS to be rack-mounted in one of four ways:

- Flush-mounted in a 19-inch rack
- Flush-mounted in a 23-inch rack
- Forward-projection mounted in a 19-inch rack
- Forward-projection mounted in a 23-inch rack.

Option .06 -48 Vdc Operation replaces the ac supply and allows the CTS to operate with -48 Vdc primary power. A rear-panel barrier strip is provided for primary power connections.

Option .06A -24 Vdc Operation replaces the ac supply and allows the CTS to operate with -24 Vdc primary power. A rear-panel barrier strip is provided for primary power connections.

Option .07 X-Y Outputs enables you to use an X-Y recorder with the CTS to graph test data. DC outputs are provided for level, delay, and frequency measurements. AC output is provided for demodulated phase or amplitude jitter. This option plugs into a short option slot in the Model 3701 CTS only. Connections are made through a rear-panel barrier strip.

Option .08 4Z I/O provides four terminating impedances for VF I/O: 135 ohms, 600 ohms, 900 ohms, and 1200 ohms. This option is supplied as part of the basic unit.

Option .09 20 kHz Basic Unit Operation extends the transmission and measurement frequency range to 40 through 20,100 Hz. This option is installed on all Model 3700s with Firmware Revision 12 or later.

Option .10 120 kHz Basic Unit Operation extends the transmission and measurement frequency range to 40 through 120,000 Hz.

2.4.2 Remote Control Options

Option .25A-232 Remote Control provides the software control and interface to allow the CTS to be used in a variety of remotely controlled test applications.

Option .41 Master/Slave is designed to be used with Option .25A-232 Remote Control for remote CTS operation and the collection of data over the 4-wire line under test. When installed in both near- and far-end remotely controlled CTSs, Option .41 allows the operator to control the test functions of the far-end CTS, including collection of the far-end measurements over the line under test. The option provides a full-duplex data modem and automatic test signal/data signal control.

Option .70 EasyTest Interpreter adds the EasyTest language to Option .25A-232, and is supplied with all Option .25A-232 equipped CTSs.

Option .71-002 Master/Slave EasyTest Procedure Set adds EasyTest procedures that simplify master/slave operation of the CTS in conjunction with Option .41 and Option .25A-232. These procedures include 2-way C-conditioning, envelope delay, and 2-way D-conditioning on 4-wire facilities.

Option .71-007 Enhanced Master/Slave and REACT EasyTest

Procedure Set combines the REACT EasyTest Procedures Set with an enhanced version of master/slave procedures which can function on 2-wire or 4-wire mixed facilities. The test performed are 2-way IEEE Standard 743/Bell PUB 41009 VF and data tests such as envelope delay, intermodulation distortion, hits, phase and amplitude jitter, and P/AR.

Option .71-012 REACT 2000 EasyTest Procedure Set is a basic set of EasyTest procedures needed to operate in REACT 2000 System applications. This option is standard on all Model 3700s with Firmware Revision 17 or later.

Option .72 EasyTest Editor/RAM Buffer allows you to create, edit, and modify EasyTest procedures, and down-load macros from a controller. This option also permits measurement results to be stored for later collection. This option is standard with Option .25A-232.

2.4.3 Analog Measurement Options

Option .11 Three-Level Impulse Noise measures and displays the number of impulse noise occurrences (defined as any excursion of a band-limited signal above a preset threshold) within a specified time period. Designed to Bell PUB 41009 specifications, it provides a full three-level impulse noise distribution. This option is standard on all Model 3700s with Firmware Revision 12 or later.

Option .12A (.12) Envelope Delay, designed to IEEE Standard 743/Bell PUB 41009 specifications, measures and displays envelope delay distortion. It provides forward reference and return reference delay, and an amplitude repeat mode to provide loop measurement capability. Option .12A replaces the previously available Option .12 Envelope Delay in units with Firmware Revision 12 or later. (Option .12 may function in all units, but may require factory rework to function in units with Firmware Revision .12 or later.)

Option .13 Hits/Jitter measures and displays phase hits, gain hits, dropouts, phase and amplitude jitter in accordance with Bell PUB 41009 specifications, and CCITT Recommendations O.91 and O.95. Option .13 provides a comprehensive measurement of short-term transient effects and incidental phase and amplitude modulation that affect signals transmitted through a telephone channel.

Option .14 Intermodulation Distortion measures and displays second and third order intermodulation distortion. Option .14 is designed to IEEE Standard 743/Bell PUB 41009 specifications, and CCITT O.42 Recommendations. It measures channel intermodulation distortion using the 4-tone technique that supersedes harmonic and total distortion measurement methods.

Option .15 15-kHz Flat/Program Filters adds 15-kHz flat and US program weighting filters (C-message and 3-kHz flat filters are standard).

Option .15B 15-kHz Flat/50 kb Filters adds 15-kHz flat and 50 kilobit weighting filters.

Option .15C 15-kHz Flat/50 kb/50-kHz Flat Filters adds 15-kHz flat, 50 kilobit, and 50-kHz flat weighting filters. This option works only in units with Option .10 120 kHz Basic Unit Operation.

Option .16 Return Loss provides full 2-wire and 4-wire return loss measurement capability. Designed to IEEE Standard 743/Bell PUB 41009 specifications, it allows ERL, SRL LO and SRL High, and sine-wave measurements to be made by the CTS. The option incorporates generators for all required test signals and the echo suppressor disable tone. In units with Firmware Revision 12 or later, Option .16 is supplied as part of the basic unit.

Option .18A (.18) P/AR measures and displays the P/AR rating of a channel. Designed to IEEE Standard 743/Bell PUB 41009 specifications, P/AR (peak-to-average ratio) is a rating of the simultaneous effects of envelope delay distortion, frequency response problems, and poor return loss on voiceband data signals. Option .18A replaces the previously available Options .18 and .19 in units equipped with Firmware Revision 12 or later. (Options .18 and .19 function in all units.)

Option .30 Intermodulation Distortion and P/AR measures and displays second and third order intermodulation distortion and the P/AR rating of a channel. Option .30 is designed to IEEE Standard 743/Bell PUB 41009 specifications, and CCITT O.42 Recommendations (IMD). It measures channel intermodulation distortion using the 4-tone technique that supersedes harmonic and total distortion measurement methods. P/AR (peak-to-average ratio) is a rating of the simultaneous effects of envelope delay distortion, frequency response problems, and poor return loss on voiceband data signals. Option .30 works only in units equipped with Firmware Revision 12 or later.

Option .35A Call Progress and Signaling allows the CTS to operate in loop signaling (loop-start and ground-start) and E & M (Types I, II, III, IV, and V) signaling systems. Option .35A provides the required supervisory signaling and detection, and also features call progress tone detection. This feature enhances the operation of remotely controlled and automated REACT 2000 Systems. With Option .35A installed, test personnel can monitor call progress from a remote test control device. Option .35A can also detect DTMF tones.

Option .35C Call Progress and Signaling performs all the loop-start, ground-start, and E & M signaling functions of the Option .35A, plus it adds single frequency (SF) signaling. In addition to DTMF tone decoding, the Option .35C also decodes MF tone and dial pulse signaling. Like the Option .35A, the Option .35C performs call progress tone detection.

Option .40 VOM/CAP measures alternating and direct current and voltage, plus resistance and capacitance. Option .40 uses a sampled data measurement technique to provide excellent measurement resolution and accuracy. This technique also reduces the effects of foreign voltage and background interference on the resistance and capacitance measurements.

Option .52 Responder Interface permits the CTS to act as a near-end responder for 105-type testing, and performs CAROT-type measurements with far-end 52- and 56A-type responders. The measurements performed are loss, gain slope, noise-with-tone, C-message noise, and return loss. The option complies with Bellcore Compatibility Bulletin CB 106. Option .52 also requires Option .60 for operation.

Option .60 DTMF/MF Signaling adds DTMF/MF tone dialing capability to the CTS. In units with Firmware Revision 12 or later, Option .60 is supplied as part of the basic unit, and requires no option slot.

2.4.4 PCM Measurement Options

Option .62 PCM Test/Channel Access adds PCM channelized testing for digital circuits with T1 framing formats.

Option .64 ESF PCM Test/Channel Access adds PCM channelized testing for digital circuits with superframed (D1D, D2, D3D4), extended superframe (ESF), and SLC-96 framing formats.

Option .65 T1 Bit Error Ratio adds out-of-service bit error ratio measurements to units equipped with Option .64 ESF PCM Test/Channel Access. The Option .65 operates at both the DS1 (1.544 Mbps) and channelized (64 kbps) rates. The option generates a variety of pseudorandom test patterns, user-defined patterns, all ones, alternating ones and zeros, 3-in-24 stress pattern, as well as CSU and SMJ loopup and loopdown codes. For the channelized rate, Remote Data Loopback (RDL) or DS0A latching loopback (OCU, CSU, and DSU) codes are generated according to CCITT Recommendation V.54. For the DS1 rate of 1.544 Mbps, Remote Data Loopback 1 (RDL1) codes are generated. The option also performs error injection, channelized round-trip delay measurements, and provides a unique frequency difference measurement.

2.5 Equipment Specifications

This section contains the following tables which further detail specifications for the Model 3701/3705 and its options:

- Table 2-3 Model 3701/3705 w/Option .64 Specifications
- Table 2-4 Option .07 X-Y Outputs Specifications
- Table 2-5 Option .12A Envelope Delay Specifications
- Table 2-6 Option .13 Hits/Jitter Specifications
- Table 2-7 Option .25A-232 Remote Control Specifications

- Table 2-8 Option .30 Intermodulation Distortion and P/AR
- Table 2-9 Option .35C Call Progress and Signaling
- Table 2-10 Option .40 VOM/CAP Specifications
- Table 2-11 Option .41 Master/Slave Specifications
- Table 2-12 Option .52 Responder Interface Specifications
- Table 2-13 Option .65 T1 Bit Error Ratio Specifications

NOTE: Hekimian reserves the right to make changes in specifications at any time without notice.

Table 2-3. Model 3701/3705 w/Option .64 Specifications

PCM GENERAL

Operating Mode	Channel access from a digital T1 line, or from a DCS test digroup in Monitor/Idle, or Drop-and-Insert.
Digital Code	DS1 frame formats, D1D, D2, D3D4, Extended Superframed Format (ESF), SLC-96; line code, AMI or B8ZS selectable.
Companding Law	μ = 255 coding

VF GENERAL

Operating Mode	2W (2-wire) and 4W (4-wire) analog circuits
Impedance	600 Ω , 900 Ω , 1200 Ω , bridged/150 Vdc blocking; 135 Ω , no dc blocking
Bridging Loss	<0.2 dB, 200 Hz through 20 kHz (135 Ω , 20 through 120 kHz - Option .10)
Balance	>80 dB @ 60 Hz
Return Loss	>30 dB, 200 Hz through 20 kHz (>15 dB, 20 through 120 kHz - Option .10)
Input Filter	50-kHz corner frequency
Hold/Dial/Talk	4W talk, 2W talk with dual hold circuits, and internal and external dial capability for dial pulse, DTMF, or MF digits
Automatic Dial	Stores up to 99 sets of up to 40 digits
Monitor	To/From/Talk signal switch, volume control

PCM MEASUREMENTS

Alarms Displayed	No PCM Remote frame alignment alarm Frame alignment alarm AIS (All ones)
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Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Totalizers

Types	Bipolar violations Excessive zeros Frame bit errors Multiframe bit errors (superframed only) CRC errors (ESF only) Errored seconds No PCM alarms Frame alignment alarms Remote frame alignment alarms
Count Capacity	0 through 9999
Timer Duration	0.1 minute through 100 hours

VF MEASUREMENTS*

Level/Frequency**

Level	+10 through -70 dBm (+10 through -50 dBm - Option .10)
Frequency	40 Hz through 20.1 kHz (40 Hz through 120 kHz - Option .10)
Measurement Accuracy	± 0.1 dB @ 1000 Hz, 0 through -19 dBm ± 0.2 dB @ 200 Hz through 15 kHz, +10 through -50 dBm ± 0.5 dB @ 40 Hz through 20 kHz, +10 through -50 dBm (± 0.5 dB @ 20 through 70 kHz, +10 through -40 dBm - Option .10) (± 1.0 dB @ 70 through 120 kHz, +10 through -40 dBm - Option .10)
Frequency Resolution	1 Hz, 40 Hz through 20.1 kHz (10 Hz, 20.1 kHz through 120 kHz - Option .10)
Frequency Level Range	+10 through -50 dBm
Frequency Accuracy	± 1 Hz $\pm 0.01\%$ of reading 40 through 20.1 kHz (± 10 Hz $\pm 0.02\%$ of reading 20.1 through 120 kHz - Option .10)
Rel. Ref. Range	+10.0 through -40.0 dBm
TLP Range	+10 through -40 dBm, 1 dB resolution
High Pass Filter	>20 dB loss @ 60 Hz, selectable

Noise

Filters	C-Message, 3-kHz Flat, 1010-Hz Notch Program and 15-kHz Flat - Option .15 50 kilobit and 15-kHz Flat - Option .15B (15-kHz Flat, 50 kilobit, and 50-kHz Flat - Option .15C and .10)
Range	10 through 100 dBm (20 through 100 dBm - Option 15, .15B, or .15C, and .10) 40 through 130 dBm noise-to-ground (50 through 130 dBm noise-to-ground - Option .15, .15B, or .15C, and .10)

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Accuracy	±1.0 dB ±1.5 dB noise-to-ground
Signal-to-Noise	
Level Range	+10 through -40 dBm
Noise Range	20 through 90 dBm
S/N Range	+10 through +45 dB
Accuracy	±1 dB through +40 dB
Weighting	C-Notch
Three-Level Impulse Noise***	
Measurement Range	30 through 110 dBm 40 through 110 dBm with Program, 50 kilobit, and 15-kHz Flat -Options .15 or .15B (40 through 110 dBm with 15-kHz Flat, 50 kilobit, and 50-kHz Flat - Options .15C and .10)
Low Threshold	
Range	30 through 106 dBm 40 through 106 dBm with Program, 50 kilobit, and 15-kHz Flat - Options .15 or .15B (40 through 110 dBm with 15-kHz Flat, 50 kilobit, and 50-kHz Flat - Options .15C and .10)
Resolution	1 dB
Accuracy	±1 dB
Lo/Mid, Mid/High Threshold Spread	2, 4, 6, or 8 dB
Count	
Rate	7 counts/second (Bell standard) 100 counts/second (fast mode)
Capacity	9999 for LO, MID, and HI threshold totalizers
Weighting	C-Message or 15-kHz Flat - Option .15 or .15B Program - Option .15 50 kilobit - Option .15B or .15C 50-kHz Flat - Option .15C and .10; with or without 1010-Hz test tone notch
Counting Hierarchy	Used with Option .13 Hits/Jitter, impulse noise counts are optionally interlocked with hit and drop-out occurrences per Bell PUB 41009.
Timer	1 through 60 minutes and continuous up to 4 days
Setting Resolution	1 minute

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Display Resolution	0.1 minute
Return Loss	
Operating Modes	4-wire return loss 2-wire return loss
Receive Weighting	
Normal	Flat with 60-Hz high pass filter
C-Message (ERL only)	C-Message and 60-Hz high pass filters
Measurement Range	-10 through +50 dB (4W) 0 through +50 dB (2W)
Accuracy	± 0.5 dB
Echo Suppressor Disable Tone	Provides nominal 1-second burst of 2.15-kHz tone to disable any echo suppressors in test path.
Transhybrid Loss Correction (4-Wire)	± 99.9 dB
Generator	
Test Signals	SRLHI, SRLLO, ERL, designed to meet industry standard weighting, and sine wave
Level Range	0.0 through -70.0 dBm rms
Level Stability	± 0.5 dB
Harmonic Distortion	At least 30 dB down
2W Reference Impedance Selection	600 Ω in series with 2.16 μ F 900 Ω in series with 2.16 μ F 1200 Ω in series with 2.16 μ F External reference (NORM-RCV jack)

DIGITAL INTERFACE

Input

Rate	1.544 Mbps ± 200 bps
Pulse Level	
Nominal	± 3 V base-to-peak
Terminated	
Signal Present	0 through -25 dB
Signal Absent	< -32 dB

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Bridged	
Signal Present	0 through -6 dB
Signal Absent	< -13 dB
Impedance	
Terminated	100 Ω ±10%, balanced
Bridged	>1000 Ω , balanced
Output	
Rate	Slaved to receive PCM or 1.544 Mbps ±40 bps in terminal master mode
Pulse Level	±3V base-to-peak ±10% into 100 Ω
Impedance	100 Ω ±10%, balanced
Operating Modes	
In-line	
Monitor	Unmodified receive signal (if line code properly selected)
Drop-and-Insert	Received signal with BPV removed and selected channel modified
Terminal	
Idle	Idle channel code (01111111) in all channels
Drop-and-Insert	Idle channel code (01111111) in all but selected channel
DCS	
Monitor	Unmodified receive signal (if line code properly selected)
Drop-and-Insert	Received signal with BPV removed and selected test port modified
<u>ANALOG INTERFACE</u>	
Decoding	
Accuracy	0.0 ±0.1 dBm with digital mW applied
Frequency Response	±0.15 dB from 300 Hz through 3 kHz
Noise	Idle channel code received, ≤19 dBmC0
Channel Selection	Channel in selected direction decoded for measurement and signaling. Channel in other direction decoded for signaling only.
Encoding	
Accuracy	±0.1 dB @ 0 dBm, 1 kHz
Frequency Response	±0.15 dB from 300 Hz through 3 kHz
Noise	Idle channel noise with input quiet-terminated, ≤19 dBmC0

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Channel Selection

Channel in selected direction encoded for measurement and signaling.
Channel in other direction encoded for signaling only.

Decoding and Encoding

Signal to Quantization Distortion			
Minimum S/D			
Input Level	Output	Input	Overall
0 to -30 dBm0	35 dB	35 dB	33 dB
-30 to -40 dBm0	29 dB	29 dB	27 dB
-40 to -45 dBm0	25 dB	25 dB	22 dB
Tracking Gain Error			
Maximum Deviation			
Input Level	Output	Input	Overall
+3 to -37 dBm0	0.25 dB	0.25 dB	0.50 dB
-37 to -50 dBm0	0.50 dB	0.50 dB	1.00 dB

SIGNALING

PCM

Channel Selection

Slaved to channel selected for analog testing

Control

Signaling state directly controlled by user

Features

Wink detection, dial pulsing, and FX-type supervision

Digital Bit

Superframed

A and B; robbed-bit

ESF

2-state (AAAA), 4-state (ABAB), and 16-state (ABCD); robbed-bit

Single Frequency (SF)

Send Frequency

2604 Hz, ± 1 Hz

Send Level

-8 and -20 dBm0

Receiver Sensitivity

-29 dBm0, guarded detection with guard release

VF*

Loop-start supervisory signaling; dial pulse, DTMF or MF digits

DTMF/MF Signaling

DTMF Digits

Tone Duration

80 ms

Interdigit Interval

80 ms

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

MF Digits	
Tone Duration	
KP1, KP2	120 ms
All others	75 ms
Interdigit Interval	75 ms
Frequency Accuracy	$\pm 0.7\%$
Level Accuracy	± 0.5 dB, composite rms
Amplitude Twist	0 dB, nominal
<u>VF SIGNAL GENERATOR</u>	
Frequency Range**	40 through 20,004 Hz (40 Hz through 120 kHz - Option .10)
Frequency Accuracy	$\pm 0.01\%$
Frequency Resolution	1 Hz with selectable steps of 1, 10, 100, or 1000 Hz (also 10 kHz - Option .10)
Frequency Offset	
1-Hz step	No offset
All others	4-Hz offset
Level Range	+10 through -70 dBm, 0.1 dB resolution
Level Accuracy**	± 0.1 dB @ 1000 Hz, 0 through -19 dBm ± 0.2 dB @ 40 Hz through 15 kHz, +10 through -40 dBm ± 0.5 dB @ 15 through 20 kHz, +10 through -40 dBm (± 1.0 dB @ 20 through 120 kHz, +10 through -40 dBm - Option .10)
Modes	1004 Hz @ -16 dBm, manual set, automatic sweep, quiet termination, loopback tone (2713 Hz)
SF Skip Range	2450 through 2750 Hz
Distortion	> 50 dB down from fundamental, 100 Hz through 4 kHz > 40 dB down from fundamental, 4 through 20 kHz (> 40 dB down from fundamental, 4 through 120 kHz - Option .10)
Sweep Rates	0.3, 1, or 3 steps/second
<u>CONNECTORS</u>	
Digital	
PCM	Normalizing bantam jacks (4) (Model 3705), rear-panel barrier strip (Model 3705 and Model 3707)
ESF Facility Data Link	DB-9S (2) RS-232-C, synchronous interface (Model 3705 and Model 3707)

Table 2-3. Model 3701/3705 w/Option .64 Specifications (continued)

Analog	Normalizing bantam jacks (2) (Model 3705), rear-panel barrier strip (Model 3705 and Model 3707) Normalizing 310 jacks (2), rear-panel barrier strip (Model 3701)
Dial/Talk	Bantam jack (1) (Model 3705) 310 jack (1) (Model 3701)
<u>POWER REQUIREMENTS</u>	
Standard	105-130/210-260 Vac (switch-selectable), 47-63 Hz, 80 watts maximum depending on options selected
Option .06	-48 Vdc nominal, 40-60 Vdc, 80 watts maximum
Option .06A	-24 Vdc nominal, 20-30 Vdc, 80 watts maximum
<u>SIZE</u>	15 in. (38.1 cm) W x 5.25 in. (13.3 cm) H x 18.5 in. (47 cm) D
<u>WEIGHT</u>	20.5 lb. (9.3 kg)
<u>ENVIRONMENTAL REQUIREMENTS</u>	
Temperature Range	
Operating	+32 through +122 °F (0 through 50 °C)
Storage	-40 through +158 °F (-40 through +70 °C)
Humidity	
Operating	5 through 95 % relative humidity, without condensation
Storage	5 through 90 % relative humidity, without condensation
*Refer to option list for optional capabilities.	
**PCM channel range and frequency response are less than VF capabilities.	
***All specifications intended to comply with Bell System Technical Reference PUB 41009 dated May 1975.	

Table 2-4. Option .07 X-Y Output Specifications

OUTPUTS

Level

Range	+1 through -4 Vdc, corresponds to level range of +10 through -40 dBm
Scale	0.1 V/dB
Resolution	0.2 dB

Delay

Range	± 5 Vdc, corresponds to measured delay range of ± 10 ms
Scale	0.5 V/ms
Resolution	5 μ s
Options Required	Option .12 or .12A Envelope Delay

Frequency

Range	0 through +5 Vdc, corresponds to low to high sweep limit
Scale	0.042 through 19.5 V/kHz, dependent on sweep range
Resolution	Sweep range divided by 256, or 1 Hz, whichever is greater

Phase Jitter/Amplitude Jitter

Range	0 through 3 Vac peak
Scale	0.1 V/ $^{\circ}$ (phase jitter) 0.1 V/% (amplitude jitter)
Options Required	Option .13 Hits/Jitter

OUTPUT ACCURACY

Phase Jitter/Amplitude Jitter	$\pm 5\%$ of indication
Level, Frequency, and Delay	Basic unit or applicable option accuracy $\pm 2\%$ of full scale

OUTPUT IMPEDANCE

2,000 Ω

EXTERNAL CONNECTIONS

Rear-panel barrier strip

OPTION SIZE

1 short option slot

WEIGHT

4 oz. (114 g)

Table 2-5. Option .12 and .12A Envelope Delay Specifications

<u>OPERATING MODES</u>		
Delay	Master	
Delay/Delay plus Amplitude	Slave	
<u>DELAY MEASUREMENT</u>		
<u>(Master and Slave)</u>		
Carrier Frequency Range	200 Hz through 4 kHz	
Carrier Level Range	+10 through -40 dBm	
Modulation Frequency	83-1/3 Hz	
Delay Measurement	+9000 through -3000 μ s	
Accuracy	$\pm 10 \mu$ s, 600 Hz through 4000 Hz $\pm 30 \mu$ s, 300 Hz through 600 Hz	
<u>AMPLITUDE REPEAT</u>		
<u>(Slave Only)</u>		
Carrier Range	+10 through -40 dBm	
Accuracy	± 0.5 dB	
<u>GENERATOR</u>		
Carrier	Uses basic unit generator	
Modulation Distortion	More than 55 dB below carrier	
<u>DISPLAY AVERAGING</u>		
Normal	20 periods of modulation frequency	
Damped	160 periods of modulation frequency	
<u>MEASUREMENT DISPLAY</u>		
Delay (μ s)		Caution flags: INV LEVEL INV SIG
Receive level (dBm/dBm0)		
Receive or send frequency (kHz)		
<u>OPTION SIZE</u>		
	1 long option slot	
<u>WEIGHT</u>		
	10 oz. (284 g)	

Table 2-6. Option .13 Hits/Jitter Specifications

OPERATING MODES

Hits	Phase hits Gain hits Dropouts
Jitter	Phase jitter Amplitude jitter

RECEIVE HOLDING TONE
(All Measurements)**Frequency Range**

Hits	995 Hz through 1025 Hz
Jitter	990 Hz through 1030 Hz

Level Range

+10 dBm through -40 dBm

PHASE HIT MEASUREMENT

5 through 50° peak-to-peak in 5° steps

GAIN HIT MEASUREMENT ± 1 through ± 10 dB in 1 dB steps**DROPOUT MEASUREMENT**12 $\pm$ 1 dB**GUARD INTERVAL**

4 ms (hits, dropouts)

COUNT

Rate	Standard (7 counts/second) Fast (100 counts/second)
-------------	--

Capacity

9999 maximum (for all totalizers)

HITS/DROPOUT
INTERLOCK*

When used with Impulse Noise Option .11, impulse noise counts are interlocked with hit and dropout occurrences.

TIMER

Range	1 through 60 minutes, and continuous up to 4 days
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Setting Resolution

1 minute

Display Resolution

0.1 minute

PHASE JITTER
MEASUREMENT

0.0 through 30.0° peak-to-peak

AMPLITUDE JITTER
MEASUREMENT

0.0 through 30.0% peak

ACCURACY $\pm 5\%$ of reading, ± 2 least significant digits**WEIGHTING**Standard (20 - 300 Hz)
Standard + LF (extended low frequency range)

Table 2-6. Option .13 Hits/Jitter Specifications (continued)

<u>GENERATOR</u>	1004-Hz holding tone supplied by basic unit generator	
<u>SELF-TEST</u>		
Phase Jitter	21.4 ± 1.3° peak-to-peak	
Amplitude Jitter	18.6 ± 1.1% peak	
<u>MEASUREMENT DISPLAYS</u>		
Hits	Phase hit totalizer Gain hit totalizer	Dropout totalizer Timer (min.)
Jitter	Phase (° peak-to-peak) Amplitude (% peak)	Receive level (dBm) Receive frequency (kHz)
<u>OPTION SIZE</u>	1 long option slot	
<u>WEIGHT</u>	11 oz. (312 g)	

*All specifications intended to comply with Bell System Technical Reference PUB 41009 dated May 1975.

Table 2-7. Option .25A-232 Remote Control Specifications

<u>RS-232-C INTERFACE</u>	
Character Type	ASCII
Rate	110,300,600,1200,4800,9600 bps asynchronous; selectable
Word Length	7 or 8 bits; selectable
Stop Bits	1 or 2 bits; selectable
Parity	Odd, even or none; selectable
Mode	Full duplex
<u>COMMAND LANGUAGE</u>	
Mnemonics	4 alphabetical characters
EasyTest	Programmed test sequences
<u>SPECIAL FEATURES</u>	
Data Buffering	Storage of test results to be retrieved at user's discretion (Option .74 Data Buffer is standard in Option .25A-232)
Printer Drive Mode	Permits results on display to be routed to serial interface printer
Calendar Clock	Allows printing of minute, hour, day, month, and year
Battery Back-up	Nonvolatile storage of user-entered EasyTest procedures

Table 2-7. Option .25A-232 Remote Control Specifications (continued)

EasyTest Editor	User programmable EasyTest procedures (Option .72) is standard in Option .25A-232.
<u>OPTIONS</u>	
Master/Slave EasyTest	4-wire C and D-conditioning tests (Option .71-002)
Enhanced Master/Slave EasyTest	2-wire and 4-wire C and D-conditioning tests (Option .71-007)
<u>CONNECTORS</u>	DB-25S industry standard
<u>OPTION SIZE</u>	1 long option slot
<u>WEIGHT</u>	13 oz. (369 g)

Table 2-8. Option .30 Intermodulation Distortion and P/AR Specifications

<u>INTERMODULATION DISTORTION MEASUREMENTS</u>	
Input Signal Level Range	0 through -40 dBm
Test Frequencies	857, 863, 1372 and 1388 Hz
Distortion Product Frequencies	2nd order; centered at 520 and 2240 Hz 3rd order; centered at 1900 Hz
S/N Test	Deletes one tone pair and raises level of remaining tone pair by 3 dB
Distortion Measurement	
Range	10 through 70 dB below signal for 2nd, 3rd order products
Resolution	1 dB
Accuracy	±1 dB
4-Tone Signal Generator	
Level Range	0.0 through -70.0 dBm rms
Level Accuracy	±1 dB
Harmonic Distortion	35 dB or more below individual tone level
Self-Test	35 dB 2nd and 3rd order products
Specifications	IEEE Standard 743/Bell PUB 41009, CCITT Rec. O.42
<u>PEAK-TO-AVERAGE (P/AR) MEASUREMENTS</u>	
Level Range	0 through -40 dBm

Table 2-8. Option .30 Intermodulation Distortion and P/AR Specifications (continued)

Measurement Range	0 through 120 P/AR units
Detection	Full-wave rectified average and absolute peak
Accuracy	± 2 P/AR units (30-110 units) ± 4 P/AR units (0-120 units)
Resolution	1 P/AR unit
Line Signal Stability	64 ms period, $\pm 0.1\%$
Self-Test	59 P/AR unit test signal
Specifications	IEEE Standard 743/Bell PUB 41009
<u>OPTION SIZE</u>	1 long option slot
<u>WEIGHT</u>	9 oz. (256 g)

Table 2-9. Option .35C Call Progress and Signaling Specifications

<u>E&M SIGNALING</u>	
Types Accommodated	Types I, II, III, IV, and V
Detection Capability	Busy/Idle on E&M leads
Control Capability	Thru, split, independent seizure of E or M leads
<u>GROUND-START SIGNALING</u>	
Detection Capability	Tip ground Busy/Idle/Ring
Control Capability	Ring ground Loop closure (with Model 3700 hold circuit) Battery feed
<u>LOOP-START SIGNALING</u>	
Detection Capability	Busy/Idle/Ring Reverse battery
Control Capability	Loop closure (with Model 3700 hold circuit) Battery feed
<u>SF SIGNALING</u>	
Detection Capability	SF present or absent
Detection Bandwidth	± 30 Hz at 2600 Hz

Table 2-9. Option .35C Call Progress and Signaling Specifications (continued)**Detection Sensitivity**

Maximum	+6 dBm0 (must detect)
Minimum	-28 dBm0 (must detect) -30 dBm0 (must not detect)

Control Capability

SF on/off (2600 Hz, 8 and 20 dB below send level setting)

WINK DETECTION

Short Wink	Less than 100 ms
Wink	100 ms through 350 ms
Off Hook	Greater than 350 ms
No Detection	No off-hook interval
Sources	Reverse battery, E or M lead, SF, or A/B bit with Option .62 or .64

**CALL PROGRESS TONE
DETECTION****Tones Detected**

Dial Tone	350 & 440 Hz, 525 & 660 Hz, or 480 & 620 Hz
Line Busy	480 & 620 Hz, 60 interruptions per minute
Trunk Busy	480 & 620 Hz, 120 interruptions per minute

Tone Level Range

0 through -35 dBm0 each tone

Allowable Twist ± 10 dB**ADDRESS TONE DETECTION****DTMF**

Tones Detected	DTMF digits 0 through 9, *, #, and A-D
Tone Duration	40 ms detect
Interdigit Duration	40 ms must respond
Tone Level Range	0 through -25 dBm0 composite

MF

Tones Detected	MF digits 0 through 9, KP1, KP2, ST, Code 11 and 12
Tone Duration	55 ms must detect KP1, KP2 30 ms must detect all other tones
Interdigit Duration	30 ms must respond
Tone Level Range	0 through -25 dBm0 each tone
Allowable Twist	± 6 dB

Table 2-9. Option .35C Call Progress and Signaling Specifications (continued)

<u>DIAL PULSE DETECTION</u>	
Pulses per Second	3 through 13 pps at 60% BK
Percent Break	45 through 70% at 10 pps
Sources	Loop status, E or M lead, SF, or A/B bit with Option .62 or .64
<u>OPTIONS</u>	Nonstandard call progress tone detection
<u>OPTION SIZE</u>	1 long option slot 1 short option slot
<u>WEIGHT</u>	1 lb. 8 oz. (609 g)

Table 2-10. Option .40 VOM/CAP Specifications

<u>DISPLAY RESOLUTION</u>	3 digits maximum
<u>DC VOLTAGE</u>	
Range	0.0 through ± 200 Vdc
Accuracy	$\pm 2\%$ of reading ± 0.2 Vdc
Input Resistance	100 k Ω
<u>AC VOLTAGE</u>	
Range	0.0 through 160 Vac
Accuracy	$\pm 3\%$ of full scale (20 Hz through 5 kHz)
Input Impedance	100 k Ω shunted by approximately 100 pF
Detector Response	Average responding, sine wave rms calibrated
<u>DC CURRENT</u>	
Range	0.0 through ± 200 mA
Accuracy	$\pm 2\%$ of reading ± 0.2 mA
Voltage Burden	300 mV (1 Ω + fuse)
<u>AC CURRENT</u>	
Range	0.0 through 200 mA
Accuracy	$\pm 3\%$ of full scale (20 Hz through 5 kHz)
Voltage Burden	300 mV (1 Ω + fuse)
Detector Response	Average responding, sine wave rms calibrated

Table 2-10. Option .40 VOM/CAP Specifications (continued)

RESISTANCE**Range**

Low 0.000 through 99.9 k Ω
0.100 through 2.00 M Ω

High 0.000 through 20.0 M Ω

Accuracy $\pm 2\%$ of reading. Resistance is measured using a 100 Vdc source to minimize the effect of foreign voltages.

Maximum Output Current 1.0 mAdc

CAPACITANCE**Range**

Low 0.00 through 5.00 μ F

High 0.00 through 20.0 μ F

Accuracy $\pm 2\%$ of reading. Capacitance is measured using a 100 Vdc source.

Maximum Output Current 1.0 mAdc

OVERLOAD PROTECTION

Overload Protection Circuit During ac and dc current measurements, overload protection circuit interrupts test connection if overload occurs. A fuse is also provided for severe overload protection in current and capacitance modes.

Fuse Bussman GMT TYPE fuse, 1-1/3A, 125 Vac/60 Vdc

OPTION SIZE 1 long option slot

WEIGHT 16 oz. (454 g)

Table 2-11. Option .41 Master/Slave Specifications

<u>OPTIONS REQUIRED</u>	Option .25A-232 Remote Control
<u>FACILITY CONFIGURATION</u>	4-wire
<u>MODEM</u>	
Transmission Rate	300 bps
Modulation Type	FSK
Mark Frequency	1270 Hz
Space Frequency	1070 Hz
Pilot Frequency	2114 Hz
<u>SEND LEVEL RANGE</u>	+10.0 through -70.0 dBm (total signal is 3 dB higher)
<u>INPUT SIGNAL RANGE</u>	
Level Range	+7 through -30 dBm per tone
Skew	9 dB (1.1 through 2.1 kHz)
<u>MEASUREMENT DELAY RANGE*</u>	0 through 99 seconds
<u>PATH CONTROL CHARACTER*</u>	<ESC>, ↑, ASCII 1B or as programmed with SESC command
<u>CONNECTOR*</u>	DB-25P industry standard
<u>OPTION SIZE</u>	1 short option slot
<u>WEIGHT</u>	5 oz. (142 g)

*Option .25A-232 feature.

Table 2-12. Option .52 Responder Interface Specifications

<u>OPTIONS REQUIRED</u>	Option .60*, DTMF/MF Signaling
<u>MODE OF OPERATION</u>	CTS simulates near-end responder under front panel or remote control
<u>LINE INTERFACE</u>	4-wire or 2-wire; 600, 900 or 1200 ohms
<u>MEASUREMENTS</u>	
Types	Loss (2-way) 0.4-kHz gain slope (2-way) 1.0-kHz gain slope (2-way) 2.8-kHz gain slope (2-way) C-Notch noise (2-way) Near-end noise Far-end noise SRLLO return loss (2-way) ERL return loss (2-way) SRLHI return loss (2-way) Self-checks
Level Ranges	
Loss	+2.0 through -15.8 dBm
Gain Slope	-14.0 through -36.9 dBm
Level Accuracy	
Loss	±0.1 dB @ 1.0 kHz
Gain Slope	±0.2 dB @ 0.4, 1.0, and 2.8 kHz
Noise Ranges	
C-Message	15 through 55 dBmC
C-Notch	34 through 74 dBmC
Noise Accuracy	±1 dB
Return Loss Ranges	0 through 40 dB
Return Loss Accuracy	±1 dB
Detection	
Level	Average responding rms calibrated
Noise and Return Loss	Quasi-rms
<u>OPTION SIZE</u>	1 long option slot
<u>WEIGHT</u>	11 oz. (312 g)

*Option .60 is standard on all CTSs with Firmware Revision Level 12 or later.

Table 2-13. Option .65 T1 Bit Error Ratio Specifications**OPERATING MODES**

Framing Formats	Unframed (UF) Superframed (SF) Extended Superframed (ESF) SLC-96
Line Coding	Alternate Mark Inversion (AMI) Bipolar Eight Zero Substitution (B8ZS)
PCM Interface	(Refer to Model 3701/3705 Specifications.)

TIME MEASUREMENTS

Errors Detected	Bipolar violations Frame bit errors Multiframe bit errors Bit errors CRC block errors
Reporting Measurements	Totals since test began Last 1000 errored seconds (time stamped)* Totals in each 15-minute interval during test*
Test Results Reported	Bit error ratio Errored second** (synchronous or asynchronous) Severely errored seconds (synchronous or asynchronous) Degraded minutes Percent error free seconds (synchronous or asynchronous) Signal status** Bipolar violation ratio Synchronization lost seconds (frame and pattern) Number of synchronization losses (frame and pattern) Unavailable time

**FREQUENCY DIFFERENCE
MEASUREMENT**

Resolution	1 or 0.1 Hz
Accuracy	$\pm 0.1\%$ ± 4 or 0.4 Hz
Sources	East in, west in, internal clock
Update Rate	1 or 10 seconds, selectable

**T1 TEST PATTERN
GENERATION**

Data Patterns	511, 2047, $2^{15}-1$, $2^{20}-1$, $2^{23}-1$ pseudorandom; QRSS; user-defined 8-, 16-, and 24-bit repetitive; All ones; Alternating ones and zeros; 3-in-24 stress pattern
Timing Source	Internal clock or loop-timed from either receive direction

Table 2-13. Option .65 T1 Bit Error Ratio Specifications (continued)

Generated Data Rate	1.544 Mbps $\pm$ 40 bps (internal clock)***
Keep-Alive Signal	All ones, unframed
<u>ESF FACILITY DATA LINK MEASUREMENTS</u>	
Receive Format	Per ANSI T1.403-1989, 1 second performance report, both directions simultaneously
Errors Totalized (cumulative and current)	CRC errors (6 brackets) Severely errored framing event Frame bit errors Line code errors Slips
Test Results Reported	Errored seconds Severely errored seconds Error free seconds Unavailable seconds Discarded seconds (time with no received performance report)
<u>CHANNELIZED MEASUREMENTS</u>	
Errors Detected	Pattern bit errors Pattern slips
Test Results Reported	Pattern bit error ratio Errored seconds Severely errored seconds Degraded minutes Percent error free seconds Pattern slips Synchronization lost seconds (pattern) Number of synchronization losses (pattern) Unavailable time
Channel Selection	One of 24, clear channel or B8=1
<u>CHANNELIZED TEST PATTERN GENERATION</u>	
Data Patterns	511, 2047, $2^{15}-1$, $2^{20}-1$, $2^{23}-1$ pseudorandom; QRSS; user-defined 8-, 16-, and 24-bit repetitive (Rec. O.152)
Generated Data Rate	64 kbps or 56 kbps derived from internal clock or loop-timed from either receive direction
<u>ROUND-TRIP DELAY MEASUREMENT</u>	
Range	0 through 1000 ms
Resolution	1 ms

Table 2-13. Option .65 T1 Bit Error Ratio Specifications (continued)

Accuracy	±0.5 ms
Rate	56 or 64 kbps
<u>LOOPING CODE GENERATION</u>	
Primary Rate	
CSU	
SF	loopup: 10000, loopdown: 100
ESF	per Bellcore TR-TSY-000194, line and payload
SMJ	
SF	loopup: 11000, loopdown: 11100
ESF	per Bellcore TR-TSY-000194
RDL1 (1.544 Mbps)	per CCITT Recommendation V.54
Channelized	
RDL (56 or 64 kbps)	per CCITT Recommendation V.54
DS0A Latching Loopbacks	OCS, CSU (with 0, 1, or 2 repeaters), and DSU
<u>MEASUREMENT TIMER</u>	
Settable Duration	0.1 minute through 100 hours
<u>ERROR INJECTION</u>	
Bit Errors	Injected as a burst of 1 through 99 bit errors or at a controlled ratio from 1×10^{-9} through 2×10^{-3} errors/bit
Type	Bit errors or framing pattern bit errors
Bipolar Violations	Injected as a burst of 1 through 99 BPVs or at a controlled ratio from 1×10^{-9} through 2×10^{-3} BPVs/bit
<u>OPTION SIZE</u>	1 long option slot****
<u>WEIGHT</u>	511 g (1 lb. 2 oz.)
*Remote-control operation only.	
**Measurement made in conjunction with Option .64 ESF PCM.	
***Internal clock is a feature of Option .64 ESF PCM.	
****Option .65 can only be used in Model 3705 CTSs equipped with Option .64 ESF PCM.	

SECTION 3 - INSTALLATION

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3.1 Rack Mounting Instructions

3.1.1 Rack Mounting Options

Using Option .01, the CTS may be rack-mounted in either 19- or 23-inch equipment racks. Option .01 versions for flush mounting and 5-inch forward projection mounting are also available. These versions may be ordered by product number as follows:

<u>Product</u>	<u>Description</u>
3700-07	Opt .01 19" Flush Rack Mount
3700-08	Opt .01 23" Flush Rack Mount
3700-09	Opt .01 19" Forward Projected Rack Mount
3700-15	Opt .01 23" Forward Projected Rack Mount

3.1.2 Environmental Considerations

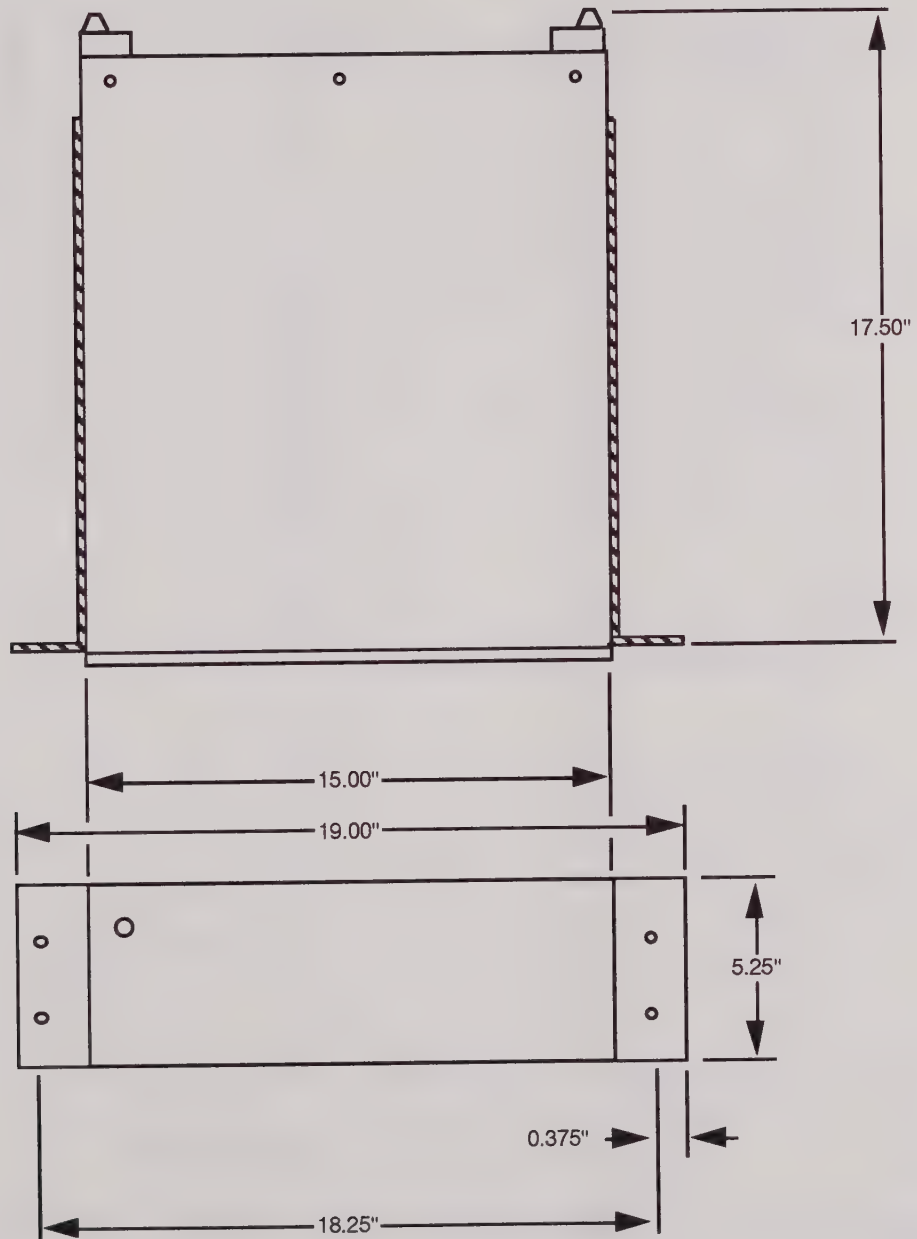
The CTS should be mounted so that airflow through the chassis vents is not impeded. Restricting the airflow may lead to overheating of the unit and possible damage. With proper ventilation, the CTS operates at ambient temperatures as high as 122 °F. A 1.75-inch space above and below the CTS is recommended. The unit also should not be exposed to excessive humidity or moisture which may condense on or in the unit. Moisture from condensation may cause unit failure.

3.1.3 Unpacking and Inspection

Remove the CTS from its shipping container and perform a complete visual inspection for possible damage. If damage is found, notify the carrier's agent immediately. Retain all packing material and the shipping container for the carrier's inspection. If the carrier's agent is not available, please contact Hekimian Customer Support at 1-800-321-0780. Do *not* return the instrument to Hekimian Laboratories, Inc., until a Return Authorization Number has been issued.

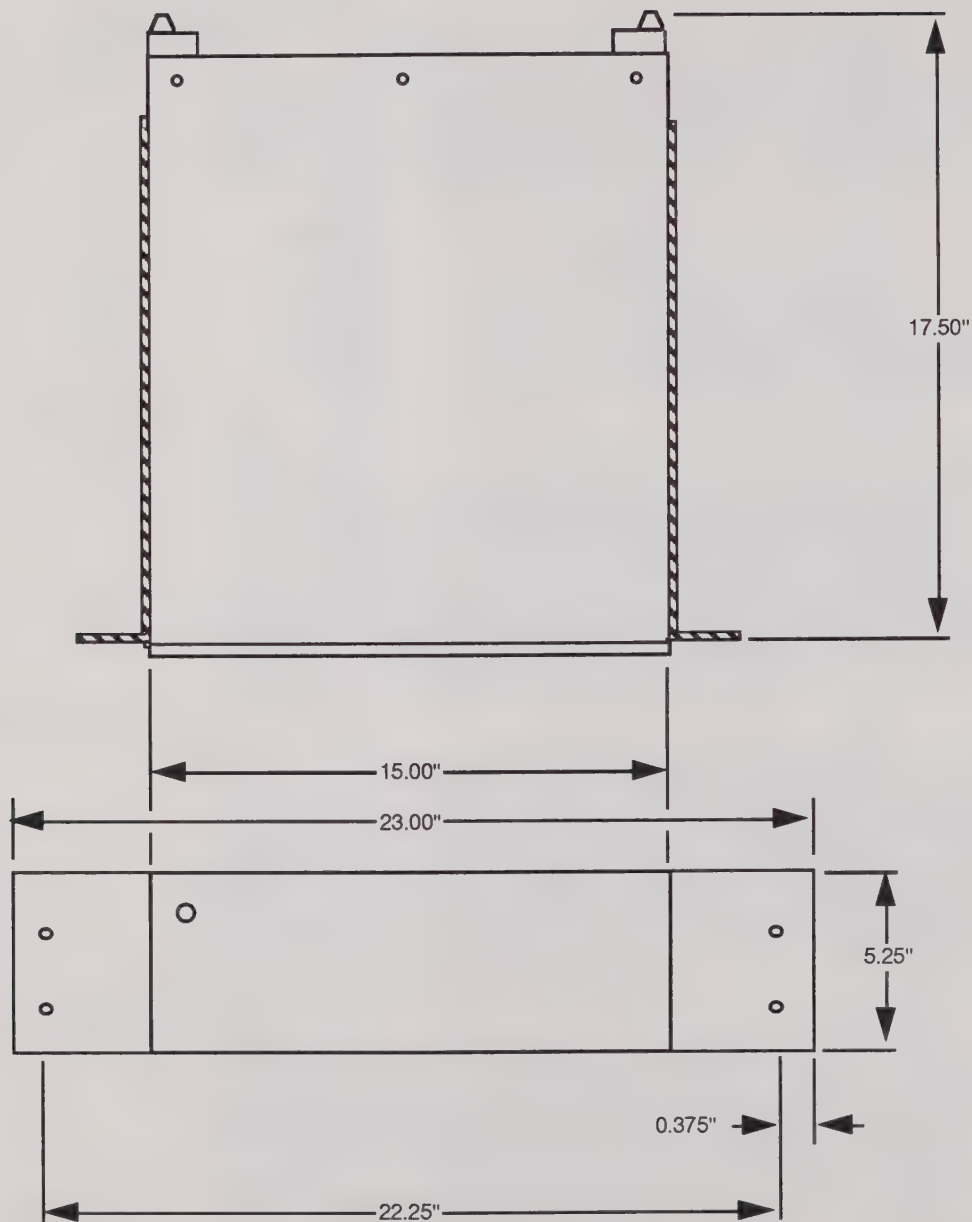
3.1.4 Rack Mounting the Unit

Figures 3-1 through 3-4 provide rack mounting details. There are no unique requirements for mounting the CTS in an equipment rack. Mounting ears are designed with slotted mounting holes spaced on standard 2.25-inch vertical hole centers for ease of alignment. Mounting hardware is *not* supplied with the unit.



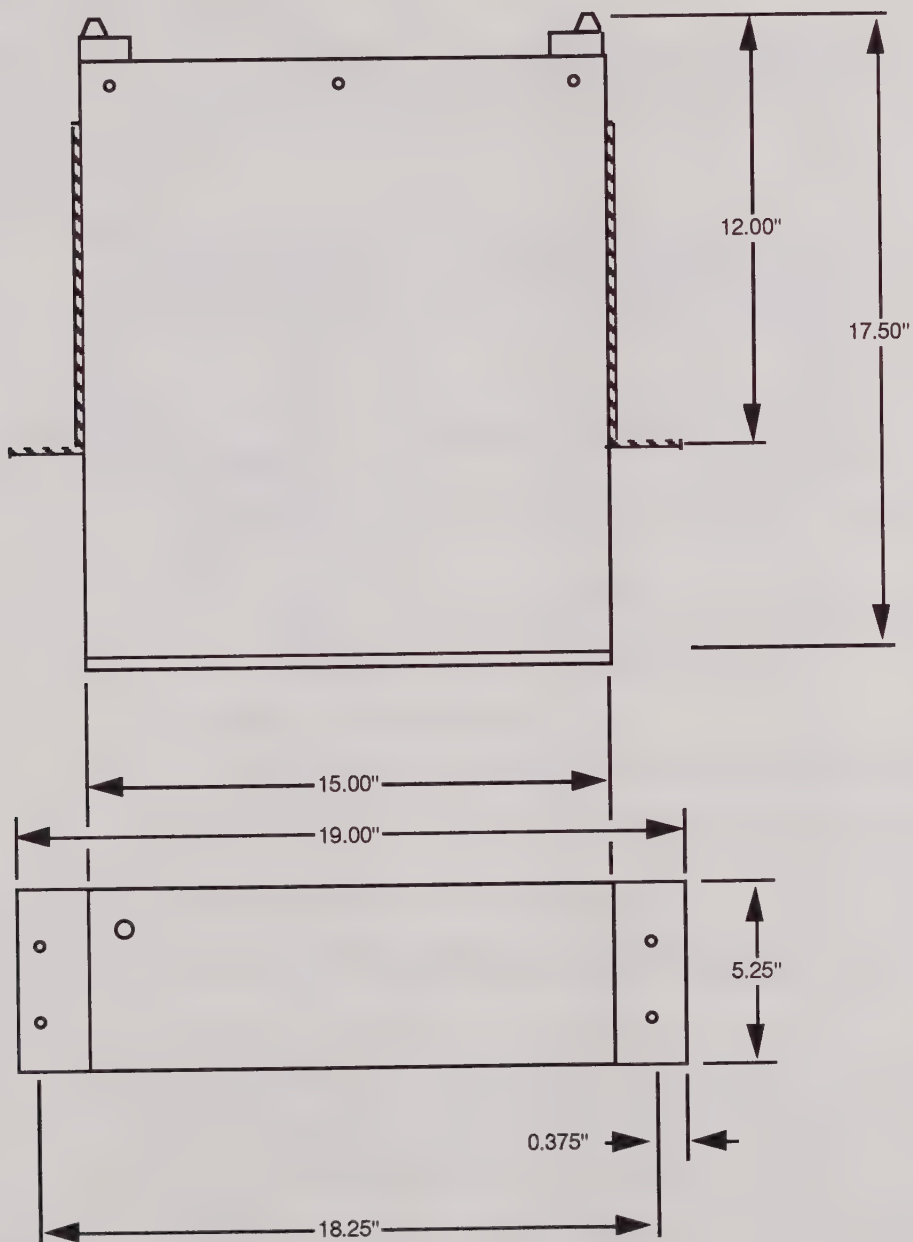
315C

Figure 3-1. 19-Inch Rack, Flush Mounting



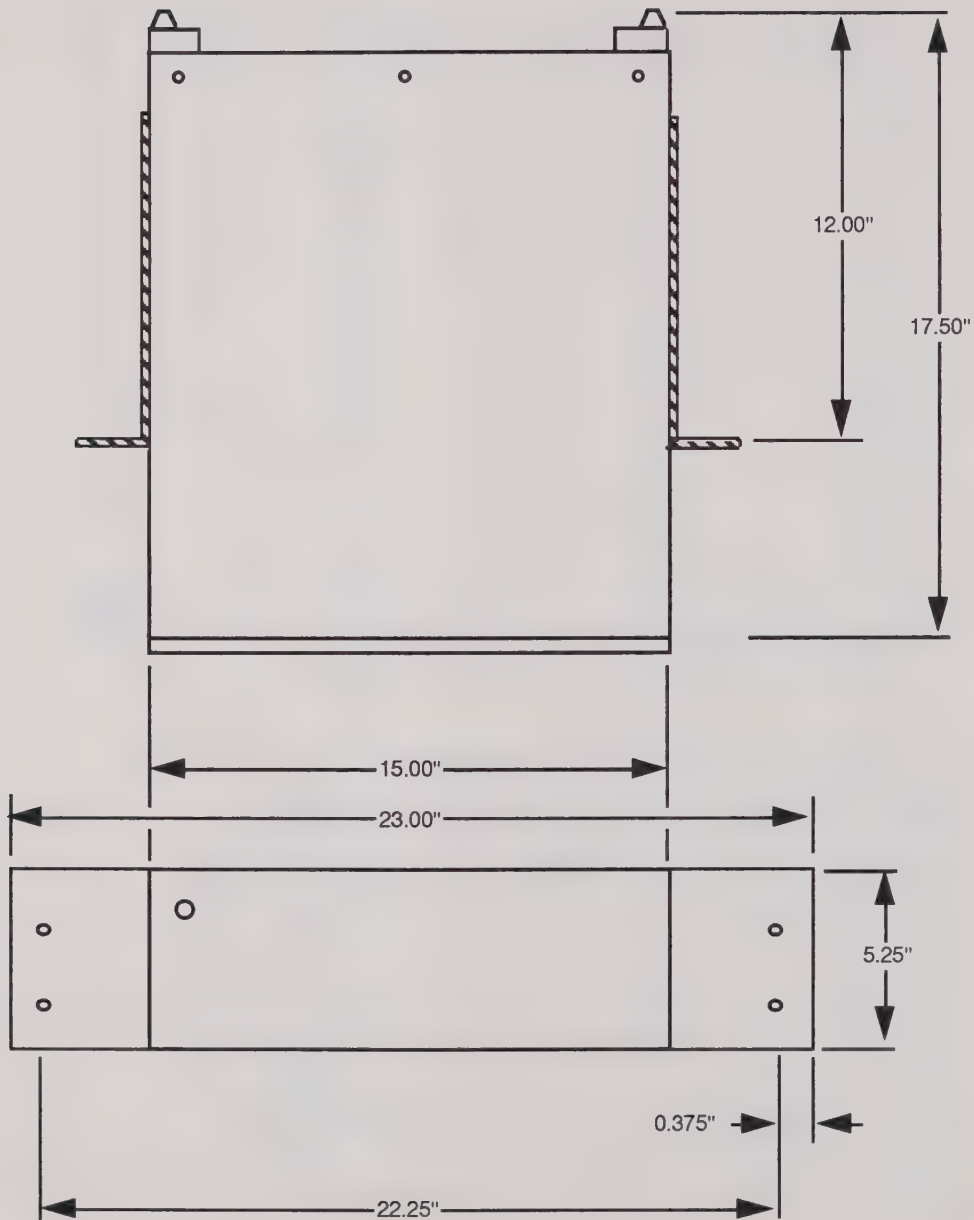
316C

Figure 3-2. 23-Inch Rack, Flush Mounting



317C

Figure 3-3. 19-Inch Rack, Forward Projection



394C

Figure 3-4. 23-Inch Rack, Forward Projection

3.2 Primary Power Connections

This section contains instructions for connecting primary ac or dc power to the CTS. The primary power requirements for the CTS are listed on the information plate mounted on the CTS rear panel.

3.2.1 AC Power Connection

For ac power operation, the CTS requires 105 through 130 Vac, or 210 through 260 Vac (switch-selectable) at line frequencies between 47 Hz and 63 Hz. A detachable, three-conductor ac power cord is supplied with the unit. Before connecting ac power to the CTS, proceed as follows:

Step	Connecting AC Power to CTS
1	Check that the CTS ac line voltage selector switch is set correctly for the available line voltage. <i>NOTE: The selected line voltage, either 115 or 230 Vac, appears on the switch. The location of the switch is shown in Figure 3-5.</i> To change the switch position - Remove the screw securing the selector switch locking tab. - Set the switch to the position that matches the available line voltage. - Replace the screw securing the selector switch locking tab. - Check that the installed fuse meets the specification stated on the CTS rear panel for the selected voltage. Replace the fuse if necessary.
2	Connect the CTS power cord to the ac power source. <i>NOTE: The ground conductor in the power cord grounds the equipment chassis to the power line earth ground. If a two-conductor outlet is used with an adapter plug, connect the adapter ground lead to an appropriate ground.</i>

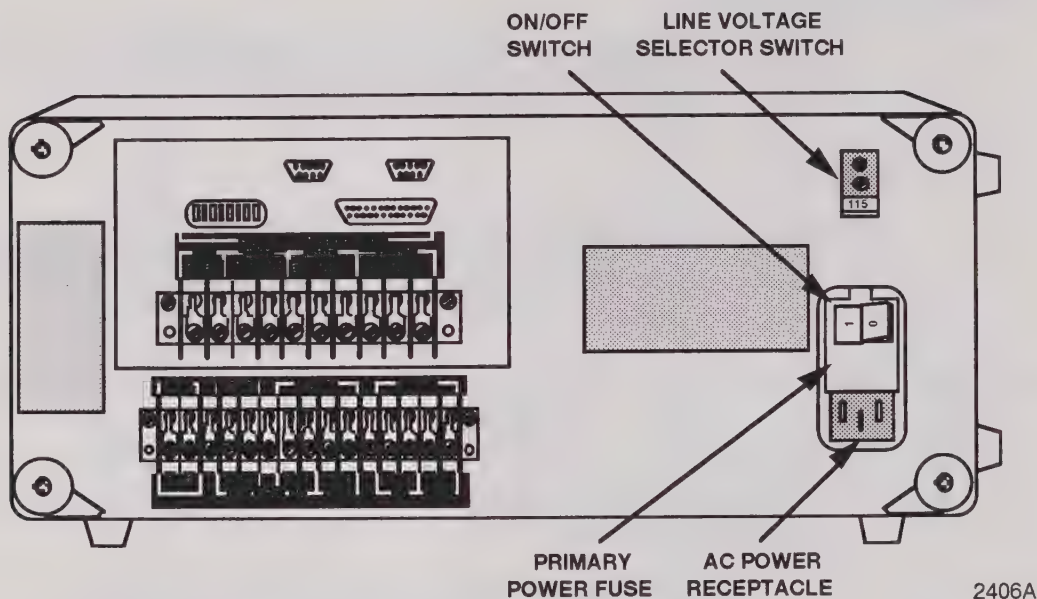


Figure 3-5. AC Power Receptacle, Line Voltage Selector Switch, Fuse Holder, and Power Switch Locations

3.2.2 DC Power Connection

A CTS ordered with Option .06, -48 Vdc Operation, or Option .06A, -24 Vdc Operation, includes a rear-panel barrier strip for dc power connections. Before connecting dc power to the CTS, proceed as follows:

Step	Connecting DC Power To CTS
1	Check that the installed fuse meets the fuse requirements stated on the CTS rear panel. Replace the fuse if necessary.
2	Connect the CHASSIS GND terminal, shown in Figure 3-6, to an appropriate ground.
3	Connect the dc power source (-48 or -24 Vdc, as applicable) to the -DC and BATTERY GND terminals.

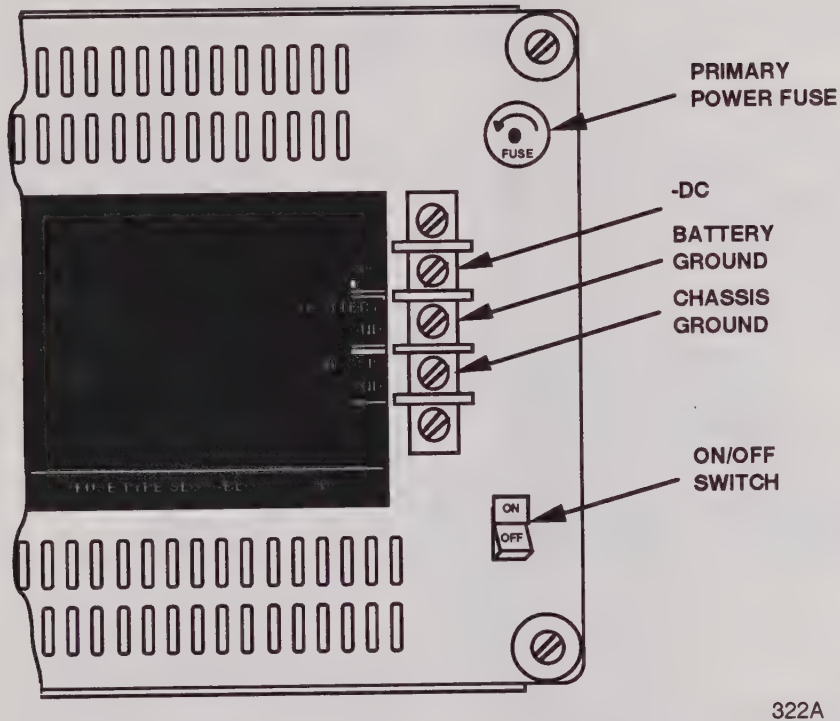
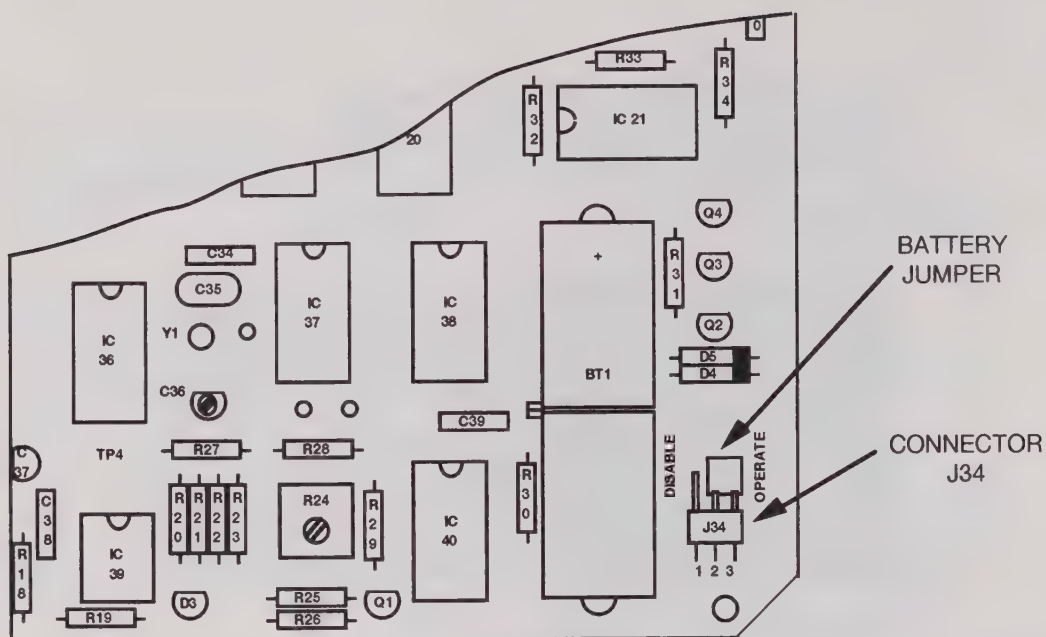


Figure 3-6. Terminals for DC Power Connection

3.3 Set-up Instructions for RS-232-C Serial Interface

If Option .25A-232 is field-installed in the CTS, the battery jumper located on the Remote Control PC Board should be placed in the OPERATE position. (See Figure 3-7). The factory-installed Option .25A-232 is shipped in the OPERATE position and requires no action. When Option .25A-232 is shipped separately from the CTS, the battery jumper is placed in the DISABLE mode.

To place the battery in the OPERATE mode, place the battery jumper over poles 2 and 3 of connector J34. To place the battery in the DISABLE mode, place the battery jumper over poles 1 and 2.



382B

Figure 3-7. Battery Jumper Installation

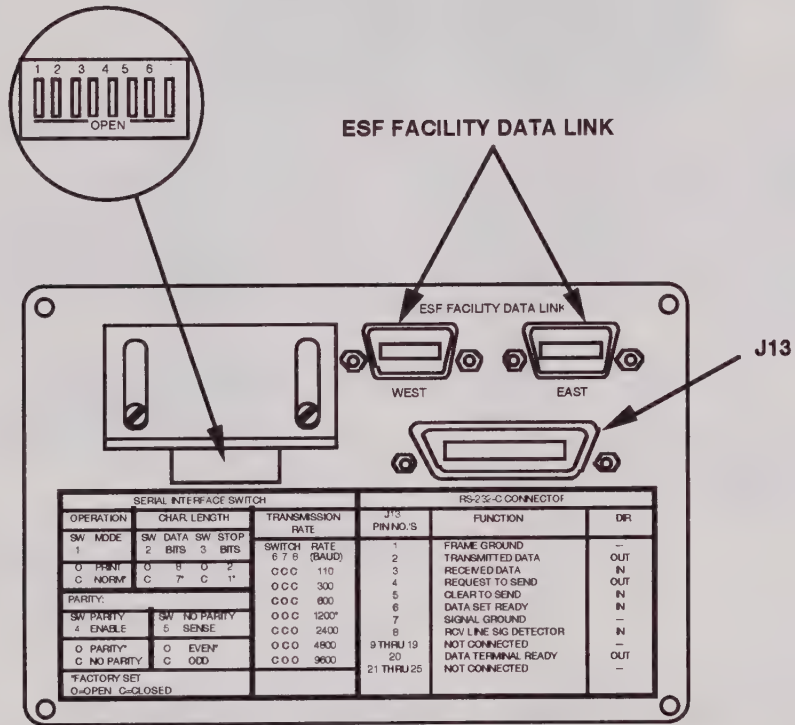
3.3.1 Setting the RS-232-C Interface DIP Switch

The operating mode, transmission rate, parity, and character length are selected through the RS-232-C INTERFACE DIP switch located behind the sliding cover on the rear panel, as shown in Figures 3-8 and 3-9. Adjust the switch settings, as needed, to configure the unit to operate with distant-end terminal equipment.

Transmission Format: The RS-232-C interface transmits and receives data in a bit-serial and byte-serial asynchronous format. The character code used is the ASCII character set. The word length is selectable between 7 and 8 bits. Parity may be enabled and is selectable as odd or even. The number of stop bits may be selected as 1 or 2 bits.

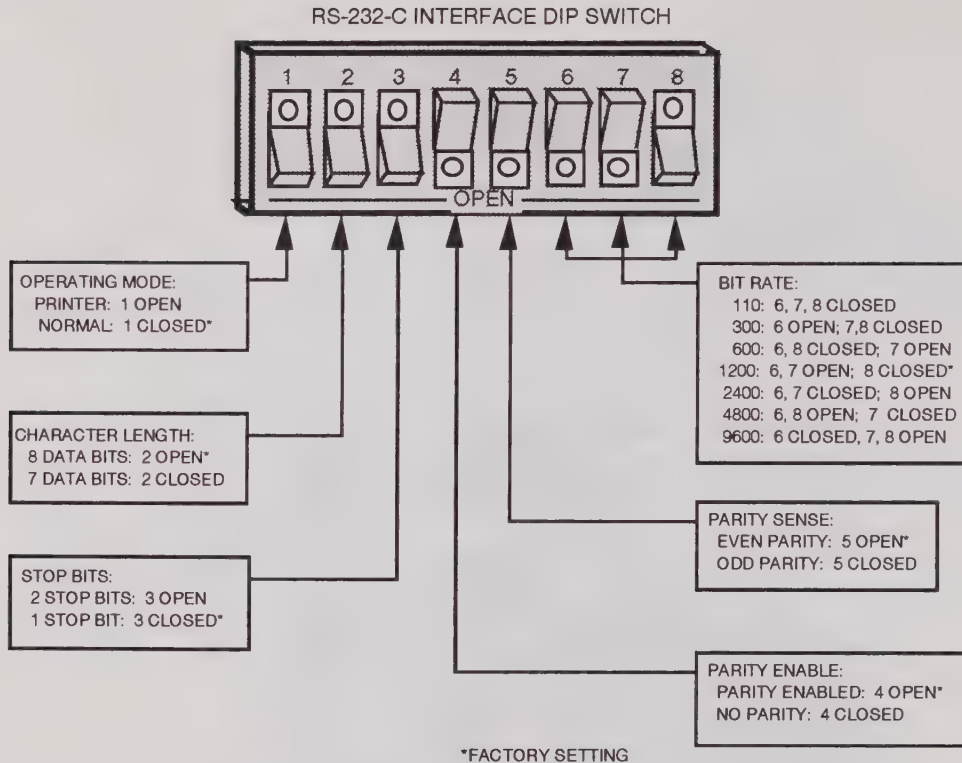
Transmission Rates: The receive and send transmission rates are the same and are user-selectable from 110 through 9600 baud.

Transmission Mode: Full-duplex transmission is used. Bell System 103A, 212A type, or other full-duplex modems may be used.



2407

Figure 3-8. RS-232-C Interface DIP Switch and Connector with Facility Data Link Connectors



1703B

Figure 3-9. RS-232-C Interface DIP Switch Settings

3.3.2 Connecting Devices to the RS-232-C Interface Connector

Option .25A-232 Remote Control allows for control of the CTS through remote data terminals. Using full-duplex modems, such as a Bell System 103A or 212A, control terminals may be connected over a voice-grade switched network or dedicated data channel. Control terminals may also be connected directly to the CTS.

Control devices connect to Option .25A-232 through the RS-232-C INTERFACE connector on the rear panel of the CTS. (A printer may be connected to this connector during front-panel operation. Refer to the set-up instructions for printer mode operation.) RS-232-C INTERFACE connector pin assignments are given in Table 3-1. The required mating connector is an industry standard, male DB-25P connector.

Review the following guidelines for connecting devices to the RS-232-C INTERFACE connector.

- In order for the Option .25A-232 to receive commands, the Data Set Ready and Receive Line Signal Detector lines must be true. For the option to send data, the Clear to Send line must also be true or tied to the Request to Send line.
- To interface the option to a modem, use a "straight-through" DTE-to-DCE (Hekimian B) cable.
- To interface the option directly to a data terminal, use a "cross-over", DCE-to-DCE (Hekimian H) cable. This cable reverses pins 2 and 3 on the connecting cable (Transmitted Data and Receive Data), ties pins 4 and 5 together (Request to Send and Clear to Send), and ties pins 6 and 8 (Data Set Ready and Receive Line Signal Detector) to "true" (for example, pin 20, Data Terminal Ready).

Table 3-1. Serial Interface Connector Pin Assignments

PIN	FUNCTION	DIRECTION
1	Frame Ground	----
2	Transmitted Data	Output
3	Received Data	Input
4	Request to Send	Output
5	Clear to Send	Input
6	Data Set Ready	Input
7	Signal Ground	----
8	Receive Line Signal Detector	Input
9-19	No Connection	----
20	Data Terminal Ready	Output
21-25	No Connection	----

3.4 Set-up Instructions for Printer Mode Operation

A CTS equipped with Option .25A-232 Remote Control may be operated in a printer mode during front-panel operation. With a serial printer connected to the RS-232-C INTERFACE connector, information displayed on the 40-character, front-panel display may be printed out.

To set the CTS for printer mode operation, set pin 1 on the RS-232-C INTERFACE DIP switch to the open position.

3.5 Line Interface Connections

On the CTS, dial tone may be connected to either front-panel jacks or to barrier strip terminals on the rear panel. To interface with 2-wire lines, connect the 2-wire line to the 2W front panel jack (NORM-SEND), or to the 2W SEND tip and ring (T_1 and R_1) contacts on the rear panel. To interface with 4-wire lines, connect the send line to the NORM-SEND front panel jack and connect the receive line to the NORM-REC jack. REV and SEND tip and ring contacts on the rear panel may also be used.

The following factors should also be considered when connecting the CTS to the T1 line:

- The CTS PCM connection consists of two matched 120 ohm balanced 4-wire interfaces. The interface labeled WEST is functionally identical to the interface labeled EAST.
- There are a variety of ways to connect the test system to the T1 line. The connection you use depends on the type of testing you want to conduct. These connections are described in the front-panel controlled operation section.
- Accessory cables are available for conversion from 120 ohm balanced bantam plug to 75 ohm unbalanced BNC male (Hekimian product number 7105-96).

3.6 Facility Data Link Connections

A Model 3700-series basic unit equipped with Option .64 ESF PCM, provides access to monitor and drop-and-insert on the facility data link of extended superframed (ESF) T1 circuits. Access is provided through two DB-9S connectors on the CTS rear panel. The logic levels and polarities are RS-232-C compatible and configured as DCE. Pin assignments for the connectors are described in Table 3-2.

Although the connectors are labeled EAST and WEST, the actual direction varies with the mode of the ESF PCM option. Table 3-3 defines the directions for each mode (in-line, terminal, and DCS).

NOTE: The receive side monitors at all times, while the send side drops-and-inserts only upon selection in the in-line and DCS mode. The send side drop-and-inserts at all times in the terminal mode. In the DCS mode, only one connector is used since only one DS1 circuit is used.

Table 3-2. Facility Data Link Connector Pin Assignments

PIN	FUNCTION	DIRECTION
1	Protective Ground	----
2	Received Data	Output
3	Transmitted Data	Input
4	Receiver Signal Element Timing	Output
5	Transmission Signal Element Timing	Output
6	Not Used	----
7	Signal Ground	----
8	Not Used	----
9	Not Used	----

Table 3-3. Facility Data Link Connector Direction

CONNECTOR	IN-LINE MODE	TERMINAL MODE	DCS MODE
EAST	East-to-West	East	Not Used
WEST	West-to-East	West	DCS

3.7 X-Y Output Connections

X-Y Outputs Option .07 enables you to use an X-Y recorder with the CTS to graph test data. DC outputs are provided for level, delay, and frequency measurements. AC output is provided for demodulated phase or amplitude jitter. This option plugs into a short option slot in the Model 3701 CTS only. Connections are made through a rear-panel barrier strip. Terminal assignments for the connectors are described in Table 3-4.

Table 3-4. X-Y Output Terminal Assignments

TERMINAL	FUNCTION
GND	Ground
DB	Level
DELAY	Delay
FREQ	Frequency
AJ/PJ	Amplitude Jitter/Phase Jitter

SECTION 4 - FRONT-PANEL CONTROLLED OPERATION

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4.1 Introduction

This section provides guidelines for operating the Model 3703 and Model 3705 Communications Test Systems (CTSs) using front-panel controls. Brief descriptions of the various front-panel controls are given in the equipment description section. Initial startup and internal self-test procedures are given in this section. VF and PCM line interface connections required prior to setup and measurement are also identified.

NOTE: The procedures contained in this section require that the CTS be installed and/or connected in accordance with instructions given in the installation section of this manual.

The CTS can be used to test both analog and digital circuits. It can perform in-service PCM error testing on digital 1.544 Mbps T1 lines, as well as analog test functions on a digital channel. The CTS allows access to any of the 24 channels that make up a T1 stream. It is compatible with superframed D1D, D2, D3D4 channel banks, extended superframed (ESF), and SLC-96 framing formats.

Robbed-bit and SF signaling functions are provided. The test set can both detect and generate signaling supervision in both directions. It can also perform wink detection and signaling, robbed-bit and SF pulsing, FX-type supervision.

The CTS may be configured in any one of three test arrangements to allow monitor and drop-and-insert PCM testing:

- INLIN (Inline) for testing in-service circuits with channels not selected passing through undisturbed
- TRML (Terminal) for looped testing of channel banks, with idle channel code (01111111) transmitting through channels not selected
- DCS (Digital Cross-connect System) for accessing both circuit directions through a test access digroup (TAD), with ports not selected passing through undisturbed.

PCM error detection takes place in both directions on the TI line when in the INLIN or DCS test arrangement. PCM error detection includes the following tests:

- Bipolar violations
- Excessive zeros
- Frame bit errors
- Multiframe bit errors (superframe only)
- CRC errors (ESF only)
- Errored seconds

In addition to error detection, the following alarms are detected and displayed as they occur:

- No PCM
- Frame alignment
- Remote frame alignment
- AIS (all ones).

With the use of the timer, the occurrences of the test and alarm conditions can be totaled for a period from 0.1 minutes through 100 hours.

4.2 Initial Startup and Checkout

This section describes how to start up the CTS, verify the system configuration (firmware level and options), and set the built-in calendar/clock.

4.2.1 Starting up the CTS

Before starting up the CTS, first ensure that primary power is properly applied to the CTS as described in the installation section. Set the power switch to the ON position. Initially, the copyright screen displays while a digital self-test performs.

4.2.2 Digital Self-Test

At powerup, the CTS performs an extensive digital self-test of its memory functions. The test runs for about 10 seconds before the VF Line Interface Setup Display appears. If an error is detected during the self-test and the CTS is still functional, an error code appears on the display. After the error code displays, the CTS holds for about seven seconds and then again runs the self-test sequence in an attempt to initialize the unit.

The error code format is as follows:

E<XXYY>

where XX = error type in hexadecimal; and YY = error address in hexadecimal. Refer to the maintenance section for more information about error codes.

4.2.3 Lamp Test

To perform a lamp test, press the LINE key in the TEST LINES section of the front panel and then the "3" key on the numeric keypad. All key-switch LEDs light momentarily, as does the 40-character display.

4.2.4 Software Revision Level Display

To display the software revision level, press the LINE key and then the "1" key on the numeric keypad. The display presents the revision level in the following format:

HLI 3705 REV F18.00 OR
HLI 3705 REV D18.00 (Option .10)

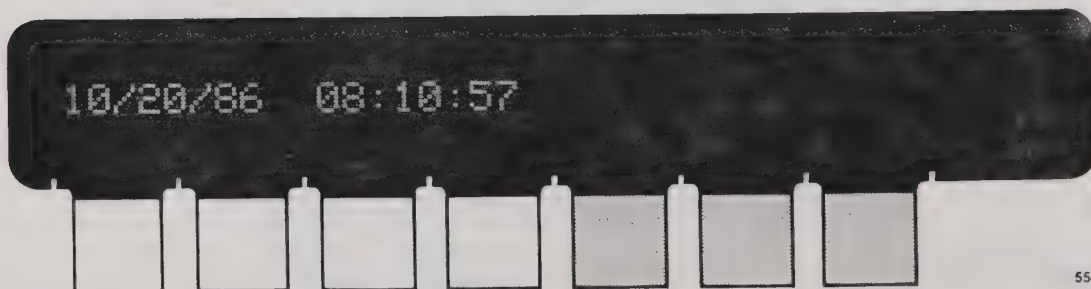
4.2.5 Installed Options Display

To display the options installed in the CTS, press the LINE key and then the "2" key on the numeric keypad. A listing of each installed option appears sequentially on the display for one second.

NOTE: Option .08 (Four Impedance VF I/O), Option .09 (20 kHz Operation), Option .11 (Three-level Impulse Noise), Option .16 (Return Loss), and Option .60 (DTMF and MF Signaling) are standard with Revision 12 or greater firmware.

4.2.6 Real-Time Calendar/Clock Display

If Remote Control Option .25A is installed, pressing the LINE key and then the "5" key on the numeric keypad causes the Real-Time Calendar/Clock Setup Display to appear as shown in Figure 4-1. The display depicts the date and time in a month/day/year and then hour:minute:second format. The clock is powered by a lithium battery on the Option .25A board, and continues to run after primary power shuts off.



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Figure 4-1. Real-Time Calendar/Clock Setup Display

Date Selection: Pressing the first soft key allows you to enter the month and day through the numeric keypad. The second soft key allows you to enter the year.

Time Selection: The third and fourth soft keys allow you to enter the hour, minute, and second through the keypad.

4.3 Printer Operation, X-Y Outputs (Option .07), and Master/Slave Control (Option .41)

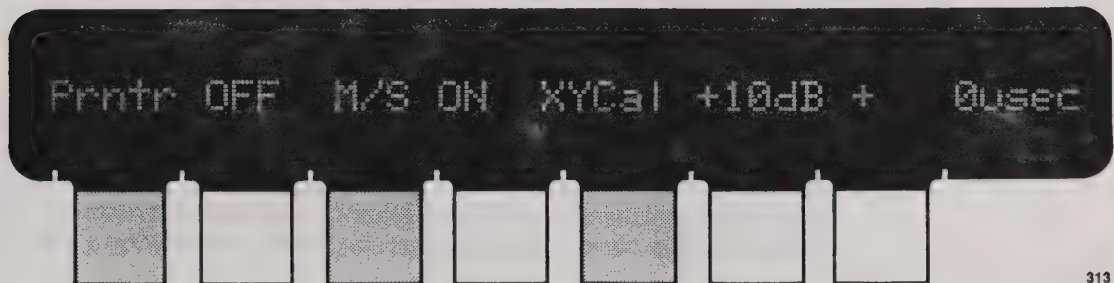
This section describes how to use a printer to print displays; how to use an X-Y calibration display to graph test results; and how to enable Master/Slave control.

NOTE: To connect an X-Y calibration display, the CTS must include Option .07 X-Y Outputs.

4.3.1 Printer Operation

For printer operation, Option .25A-232 Remote Control must be installed in the CTS and the RS-232-C interface DIP switch must have position a set to the OPEN position as detailed in the installation section.. In this arrangement, the information on the front-panel display can be routed to a serial printer through connector RS-232-C INTERFACE.

To select printer operation, press the LINE key and the "4" key on the numeric keypad. The Printer Operation Setup Display appears as shown in Figure 4-2.



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Figure 4-2. Printer Operation, X-Y Outputs, and Master/Slave Control Setup Display

NOTE: The master/slave control ON/OFF selection displays if Master/Slave Option .41 is installed. The X-Y outputs calibration selections display if X-Y Outputs Option .07 is installed.

To select printer operation, press the second soft key. The OFF characters are replaced by ON, indicating that the unit is set for printer operation. During all operations except dial/talk, pressing the "+" key on the keypad prints the displayed characters.

NOTE: When performing dial/talk operations, the "+" key controls the off-hook function.

4.3.2 X-Y Outputs (Option .07)

X-Y Outputs Option .07 generates signals for the plotting of level or delay versus frequency. With Option .07 installed, a rear-panel barrier strip on the CTS contains terminals labeled GND, DB, DELAY, and FREQ that are used when connecting a voltage-driven plotter or X-Y recorder to the CTS. The barrier strip terminal labeled AJ/PJ allows external monitoring of demodulated amplitude jitter or phase jitter. Refer to the equipment description section for Option .07 specifications.

To calibrate a plotter, press the LINE key and then the "4" key on the keypad. The X-Y Outputs Setup Display appears as shown in Figure 4-2. The sixth and seventh soft keys allow for level and delay calibration of the plotter over the following ranges:

- +10 through -40 dBm for level measurements
- -3000 through +9999 μ sec for envelope delay measurements.

NOTE: The printer operation ON/OFF selection displays if printer operation is enabled through Option .25A-232 Remote Control. The master/slave control ON/OFF selection displays if Master/Slave Option .41 is installed.

The frequency output range is determined by the low and high limit sweep frequencies established during the sweep setup. The low sweep limit frequency corresponds to an output of 0 Vdc and the high sweep limit corresponds to a +5.00 Vdc output, provided the frequency sweep range is greater than or equal to 256 Hz. Once the sweep limits are set, any point between the limits can be produced by looping the RCV and SEND (2W) jacks and readjusting the SEND display for the desired frequency. The output voltages for the limits and nominal levels are listed in Table 4-1.

Table 4-1. X-Y Output Calibration Data

TERMINAL	MEASUREMENT	MEASURED VALUE	OUTPUT (VDC)
DB	Level	-40 dBm	-4.00
		0 dBm	0.00
		+10 dBm	+1.00
DELAY	Envelope Delay (Option .12)	-3000 μ sec	-1.50
		0 μ sec	0.00
		+9000 μ sec	+4.50
FREQ	All	low sweep limit	0.00
		high sweep limit	+5.00

4.3.3 Master/Slave Control (Option .41)

Master/Slave Option .41 allows for master/slave control of the CTS. If Option .41 is installed, pressing the LINE key and the "4" key on the keypad causes the Master/Slave Control Setup Display to appear, as shown in Figure 4-2.

NOTE: The printer operation ON/OFF selection displays if printer operation is enabled through Option .25A-232 Remote Control. The X-Y outputs calibration selections display if X-Y Outputs Option .07 is installed.

To select printer operation, press the fourth soft key. The OFF characters are replaced by ON, indicating that the unit is set for master/slave operation.

Master/Slave Option .41 allows for master/slave control of the CTS. If Option .41 is installed, pressing the LINE key and the "4" key on the keypad causes the master/slave ON/OFF display to appear.

4.4 VF and PCM Line Interface

4.4.1 VF Line Interface

CAUTION: The CTS, except as defined in the specifications, is not designed to withstand long duration, high voltage, or low impedance ac and dc sources. Application of levels in excess of the normal measurement range (+10 dBm) may result in damage to the unit.

The CTS has two sets of VF balanced terminals and is capable of sending and receiving signals simultaneously. The operator can connect to the CTS through either front-panel bantam jacks or rear-panel barrier strip terminals.

CAUTION: When using the DIAL/TALK bantam jack, only use a bantam-type plug or equivalent. Use of any other type of plug can damage the contacts of the bantam jack.

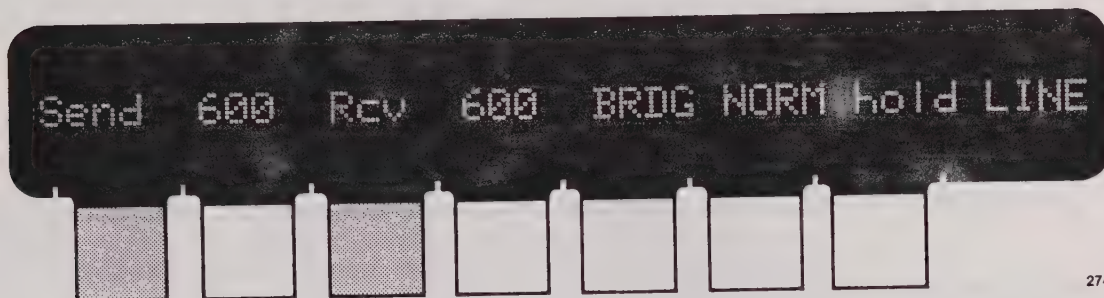
The lower left portion of the CTS front panel, labeled TEST LINES, contains bantam jacks for the lines under test; a bantam jack for an external handset; and function switches for line interface and dial/talk capability.

The VF Line Interface Setup Display, as shown in Figure 4-3, allows for line interface selections. These selections include impedance, bridge/terminate, line reversal, and hold control. The LINE key may be activated at any time during a measurement to verify the test conditions. The line interface selections may be made at any time except during the timed portion of an integrating measurement such as hits or impulse noise.

VF Line Impedance Selection: The CTS provides independently set send and receive impedances of 135, 600, 900, and 1200 ohms are provided. All impedance settings are dc blocked, except for 135 ohms. Failure to select the proper impedances causes errors in both send and receive levels.

To select the send side line impedance, press the second soft key. Selections toggle between 135, 600, 900, and 1200. To select the receive side line impedance, press the fourth soft key. Selections again toggle between 135, 600, 900, and 1200.

NOTE: If the LINE key is pressed while 2-wire operation is selected in return loss or responder interface, the setup display shows 2W and the selected impedance. All soft keys are disabled.



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Figure 4-3. VF Line Interface Setup Display

Bridge/Terminate Selection: When the CTS bridges across a receive line, the receive levels refer to the selected terminating impedance. For a bridging measurement on the receive line, toggle the fifth soft key to select BRDG. For CTS internal termination on the receive line, toggle the fifth soft key to select TERM.

Normal/Reverse Selection: The normal/reverse selection enables the send and receive jacks to be interchanged. This selection may be used in 2-wire (2W) or 4-wire (4W) operation. Normal 4W line connection is talk on the NORM-SEND (2W) jack, and listen on the NORM-RCV jack. Normal 2W connection is talk/listen on the NORM-SEND (2W) jack. Reverse 4W line connection is talk on the NORM-RCV jack, and listen on the NORM-SEND (2W) jack.

For normal line connection, toggle the sixth soft key to select NORM. For reverse line connection, toggle the sixth soft key to select REV.

Hold Control: Hold circuits are provided for both the NORM-SEND (2W) jack and the NORM-RCV jack. The hold soft key controls these circuits during dial/talk. If dial/talk is active, then the hold circuit for the selected jack is controlled by the "+" and "-" keys on the keypad, or by the hook switch on an external handset if one is installed in the DIAL/TALK jack. The selected line is the NORM-SEND (2W) jack for the NORM selection, and the NORM-RCV jack for the REV selection. The jack not selected is always controlled by the hold soft key.

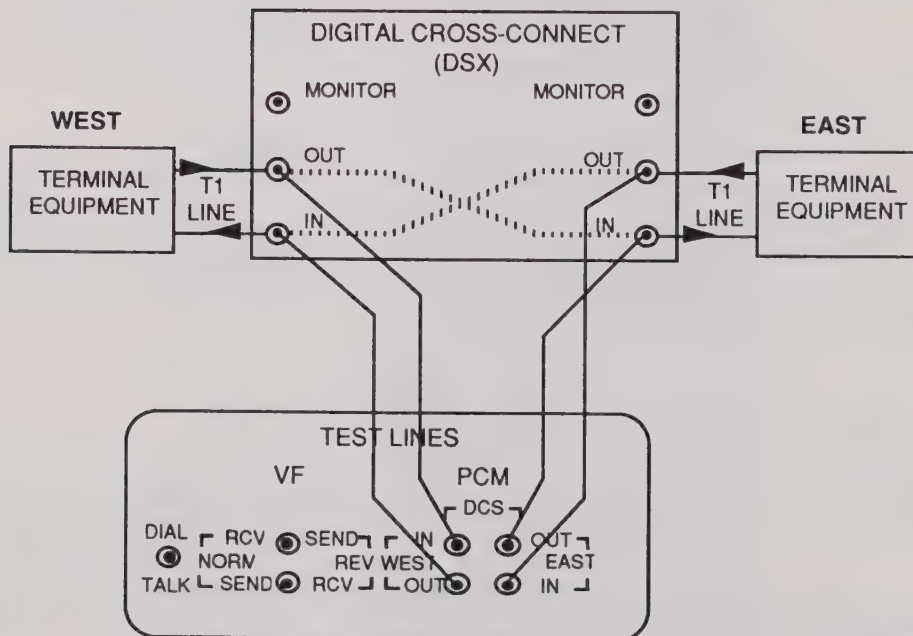
To activate the hold function, press the seventh soft key. HOLD appears in uppercase letters, indicating that the hold function is active. To toggle the function off, press the seventh soft key again. Hold appears in lowercase letters indicating that the function is off.

NOTE: The hold function is not available if NONE or E & M signaling is selected in the TALK frame.

4.4.2 PCM Line Interface

The CTS provides a 4-wire interface for the connection to the T1 line. Four bantam jacks are available to connect the transmit (output) and receive (input) pairs from both directions on the line. This makes it possible to connect the unit in series for full-duplex, inline testing. In this arrangement the T1 signal passes through the unit, allowing performance monitoring of the in-service T1 line. Figure 4-4 shows the CTS in such an arrangement.

NOTE: The PCM test line terminals are designated east and west. These are traditional reference designations for terminals in carrier systems. In these systems, circuits are designated as either west-to-east or east-to-west, depending on the direction of transmission.



254A

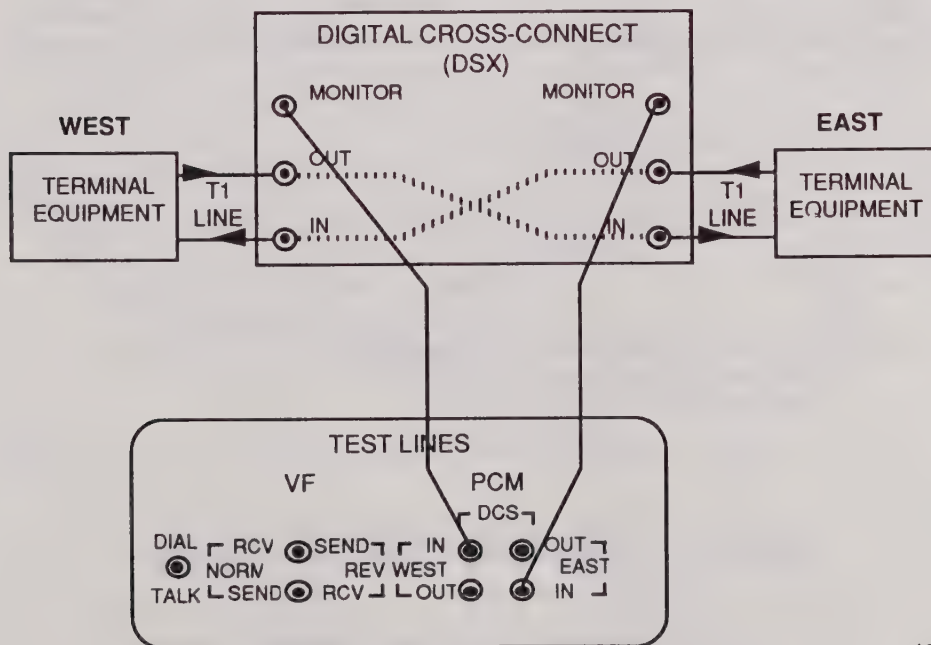
Figure 4-4. Typical Inline PCM Test Connection

The following important factors should be considered when connecting the CTS to the T1 line.

- The CTS PCM connection consists of two matched 100 ohm balanced 4-wire interfaces. The interface labeled WEST is functionally identical to the interface labeled EAST. The IN jacks may be selected for 100 ohms (TERM) or >1000 ohms (BRDG).
- There are a variety of ways to connect the test system to the T1 line. The connection you use depends on the type of testing you want to conduct. Test system connections are described in the following paragraphs.

Inline Access: To allow performance monitoring of an in-service T1 line and also conduct drop-and-insert analog testing on specific channels, you can connect the CTS through the inline access arrangement. The PCM IN jacks must be terminated for this configuration.

Monitor Access: To check for PCM fault conditions without making a test access to a specific channel. In this arrangement, you can monitor the signaling bits, and listen, but not talk, on the channel. The PCM IN jacks may be bridged or terminated for this configuration.

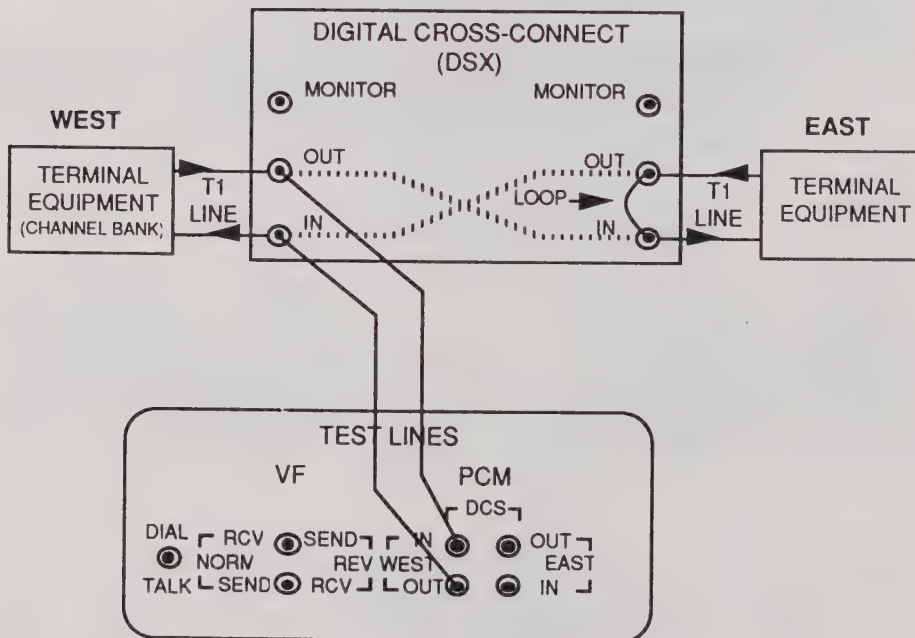


404A

Figure 4-5. Typical Monitor PCM Test Connection

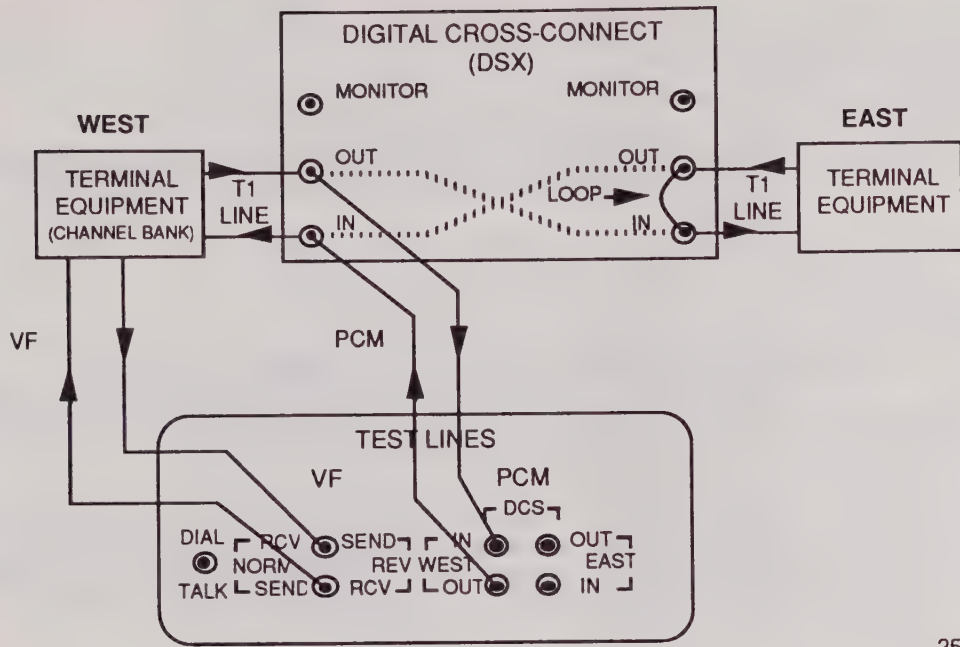
Looped or Terminal Access: To test out-of-service T1 lines, where there is no concern about disrupting traffic on the circuits, you can connect the CTS through looped or terminal test arrangements as shown in Figures 4-6 and 4-7. The CTS is used as a terminal or channel bank in this testing arrangement. The PCM IN jacks must be terminated for this configuration.

DCS Access: To connect a DCS TAD, with WEST OUT and EAST IN jacks vacant, you can use the DCS test arrangement, as shown in Figure 4-8. This permits monitoring of a channel mapped down to the DCS test port as well as drop-and-insert testing if the channel is split. The PCM IN jacks must be terminated for this configuration. Up to 12 CTSs may be daisy-chained on one DCS TAD, with each set to a separate test port and performing independent channelized testing.



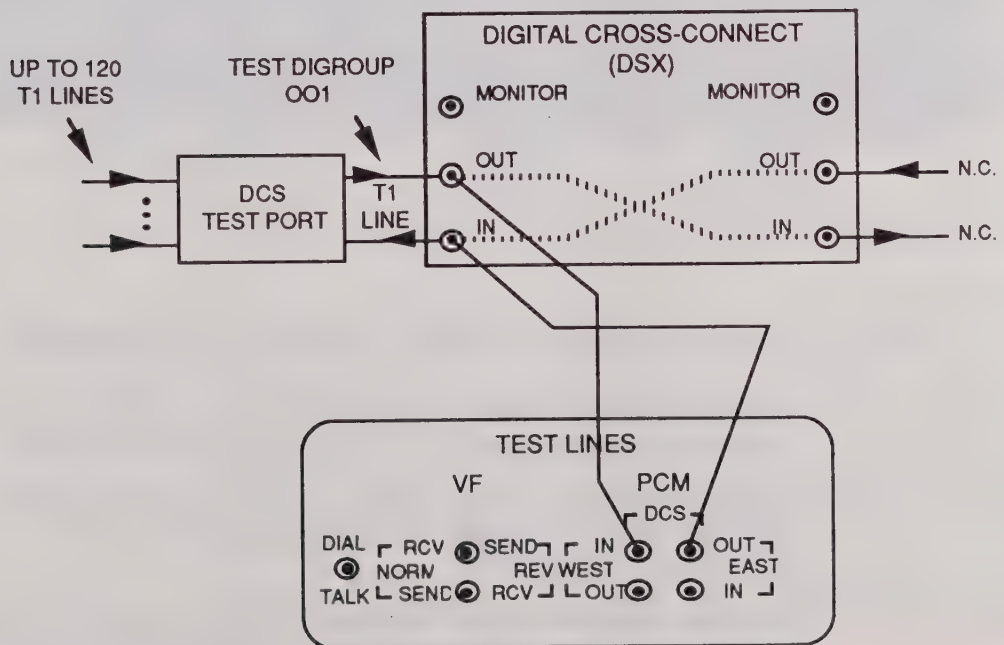
255A

Figure 4-6. Typical Terminal PCM Test Connection



256A

Figure 4-7. Typical Terminal VF to PCM or PCM to VF Test Connection



257A

Figure 4-8. Typical DCS PCM Test Connection

4.5 VF and PCM Dial/Talk Feature

The CTS offers VF dial/talk, VF dial/talk with call progress and signaling, and PCM dial/talk. The following paragraphs discuss each of the capabilities.

4.5.1 VF Dial/Talk

VF dial/talk capabilities allow pulse dialing on a 2W line, or communicating on a 4W line. The MONITOR section of the front panel activates the talk function, allows for speaker/microphone operation, and provides for the adjustment of the listening level.

To set up a VF dial/talk measurement, press the DIAL/TALK key in the TEST LINES section of the front panel. The VF Talk Setup Display appears as shown in Figure 4-9. If Call Progress and Signaling (Option .35A or .35C) is installed, a CP appears over the second soft key.



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Figure 4-9. VF Talk Setup Display (Without Call Progress and Signaling)

Dialing Selection: To select the type of dialing, press the first soft key. The choices are dial pulse (DPS), DTMF tone, or MF tone dialing.

2W/4W Selection: The third soft key toggles between 2W and 4W. The setting should be 2W for loop-start signaling, and 4W for 4W dry circuits which require no supervision.

Signaling Selection: The CTS, without options, is equipped to perform loop-start signaling on 2W wet circuits, or to disconnect the hold function for use on 4W dry circuits, such as private line data, which require no

supervision. To disconnect the hold circuit, press the fifth soft key to select NONE. Hold no longer appears in the VF Talk Setup Display.

Normal/Reverse Selection: The normal/reverse selection enables the send and receive jacks to be interchanged. TFor normal line connection, toggle the sixth soft key to select NORM. For reverse line connection, toggle the sixth soft key to select REV.

NOTE: Normal 4W line connection is talk on the NORM-SEND (2W) jack, and listen on the NORM-RCV jack. Normal 2W connection is talk/listen on the NORM-SEND (2W) jack. Reverse 4W line connection is talk on the NORM-RCV jack, and listen on the NORM-SEND (2W) jack.

Hold Control: Hold circuits are provided for both the NORM-SEND (2W) jack and the NORM-RCV jack. The hold soft key controls these circuits except during dial/talk. If dial/talk is active, then the hold circuit for the selected jack is controlled by the "+" and "-" keys on the keypad, or by the hook switch on an external handset if one is installed in the DIAL/TALK jack. The selected line is the NORM-SEND (2W) jack for the NORM selection, and the NORM-RCV jack for the REV selection. The jack not selected is always controlled by the hold soft key.

To activate the hold function, press the seventh soft key. HOLD appears in uppercase letters, indicating that the hold function is active. To toggle the function off, press the soft key again. Hold appears in lowercase letters, indicating that the function is off.

NOTE: The hold function is not available if NONE is selected in the talk setup display.

4.5.1.1 2W Dial/Talk Example

The following is an example procedure to dial and talk on a 2W circuit:

Step	2W Dial/Talk Example
1	Press the DIAL/TALK key to activate the VF Talk Setup Display.
2	To dial and talk on a 2W line, press the third soft key to select 2W.
3	Verify that the hold function is inactive. Toggle the seventh soft key so that hold displays in lowercase letters.
4	Connect the 2W line to the VF NORM-SEND (2W) jack. Press the "+" key on the keypad and listen for a dial tone on the MONITOR speaker.
5	Enter the number to be dialed through the keypad.

Step	2W Dial/Talk Example (continued)
6	Once the connection is made, the TO/FROM/TALK switch may be depressed to talk, and released to listen. Set the MONITOR control to a comfortable listening level. To talk, speak into the MONITOR speaker.
7	To maintain the connection during measurements, activate the hold function before leaving the talk setup display.
8	If it is necessary to redial, press the "-" key on the keypad to drop the line, then press the "+" key and listen for a dial tone before dialing.
9	If an external handset is used, connect the handset to the DIAL/TALK bantam jack.
10	Use the switch hook control on the handset to go off-hook. Once dial tone is received, use the handset to enter the number to be dialed.
11	To maintain the connection during measurements, activate the hold function before leaving the talk setup display.

4.5.1.2 2W Answer Example

The following is an example procedure to answer on a 2W circuit:

CAUTION: Application of incoming ring voltage to the CTS TEST LINES may cause permanent damage to the test set. Do not allow incoming ring to be applied to the RCV or DIAL/TALK jacks. Do not allow incoming ring to be applied to the SEND jack unless dial/talk is active and on-hook has been selected.

Step	2W Answer Example
1	Press the DIAL/TALK key to activate the VF Talk Setup Display.
2	To answer on a 2W line, press the third soft key to select 2W.
3	Verify that the hold function is inactive. Toggle the seventh soft key so that hold displays in lowercase letters.
4	Press the "-" key to place the selected line on-hook. This is the only safe condition for the CTS to receive incoming ring voltage. Connect the 2W line to the VF NORM-SEND (2W) jack. Listen for the incoming ring signal on the MONITOR speaker.
5	Answer the incoming call by pressing the "+" key on the keypad. Adjust the MONITOR control for a comfortable listening level.

Step	2W Answer Example (continued)
6	To maintain the connection during measurements, activate the hold function before leaving the talk setup display.
7	If an external handset is used, verify that the handset hook switch is in the monitor or on-hook condition before connecting the handset to the DIAL/TALK bantam jack.
8	With the CTS in the talk setup display, listen on the handset or MONITOR speaker for the incoming ring. Answer using the handset hook switch.
9	To maintain the connection during measurements, activate the hold function before leaving the talk setup display.

4.5.1.3 4W Talk

The following is an example procedure to talk on a 4W circuit:

Step	4W Talk Example
1	Press the DIAL/TALK key to activate the VF Talk Setup Display.
2	To talk on a 4W line, press the third soft key to select 4W.
3	Verify that the hold function is inactive. Toggle the seventh soft key so that hold displays in lowercase letters.
4	Connect the send line to the VF NORM-SEND (2W) jack and connect the receive line to the VF NORM-REC jack.
5	To talk, depress the TO/FROM/TALK switch to TALK, and speak into the MONITOR speaker.
6	To listen, release the TO/FROM/TALK switch, and adjust the MONITOR control for a comfortable listening level.
7	If an external handset is used, connect the handset to the DIAL/TALK bantam jack. The handset can now be used to talk and listen.

4.5.1.4 VF Automatic Dial

The CTS has the capability to store up to 99 dial numbers, each with up to 40 characters. This feature permits redial of an entered number with a single key press. The auto-dialing feature is controlled through the Automatic Dial Setup Display, as shown in Figure 4-10. To enter this display, first press the DIAL/TALK key and then press the SET UP key.



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Figure 4-10. VF Automatic Dial Setup Display

Dialing Selection: To select the type of dialing, press the first soft key. The choices are DPS, DTMF, or MF.

Mode Selection: The third soft key selects either the manual dialing mode (MAN), in which the keypad is used to send out digits as the keys are pressed; or the automatic dialing mode (AUTO), where the specified number is dialed with a press of the "+" key.

Automatic Dialing Entry: The fifth soft key toggles ENTER on (uppercase letters) and off (lowercase letters). When ENTER is on, the digits entered from the keypad and the special digits for DTMF and MF signaling, are stored in a register of up to 40 digits. Entering the "+" key initiates wink detection at that point in the sequence if the unit is properly equipped. Entering the "-" key causes a one-second delay in the auto-dialing sequence, to allow dialing through a PBX. When ENTER is off, entering the "+" key initiates an auto-dialing sequence. Entering the "-" key erases the sequence.

Register Number: With ENTER off, the register number is entered by pressing the sixth soft key, and using the keypad to enter a two-digit number between 01 and 99.

Display Feature: The digits entered in the register selected display by pressing the seventh soft key. The first 30 digits appear; to view the last 10 digits, press the seventh soft key a second time. To cancel the display, press the SET UP key.

The following is an example procedure for entering an automatic dial number:

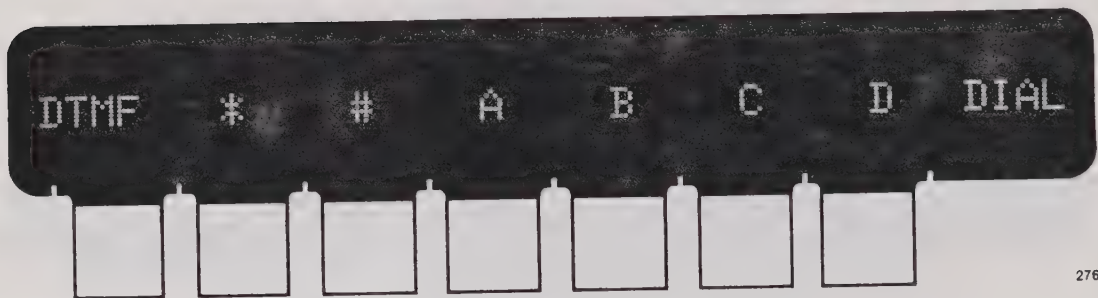
Step	Entering Automatic Dial Number Example
1	Verify that ENTER is off. If necessary, press the fifth soft key to select lowercase letters.
2	Press the sixth soft key. Using the keypad, enter the two-digit register number 01.
3	Press the seventh soft key to display the contents of the register selected to verify that the number may be erased.
4	Press the SET UP key to restore the automatic dial setup display.
5	With the first soft key, select the type of dialing (DPS, DTMF, or MF).
6	Press the fifth soft key so that enter changes to all uppercase letters. Use the keypad to enter the number to be stored in the register.
7	Press the fifth soft key to turn ENTER off.
8	Press the "+" key on the keypad to initiate the auto-dialing sequence.

4.5.1.5 DTMF/MF Signaling

DTMF/MF Signaling is standard on all test systems with Firmware Revision 12 or later. To select DTMF and MF signaling, press the first soft key in the VF Talk Setup Display. The additional digits for DTMF and MF signaling are available by pressing the SET UP key: the DTMF Signaling Dial Display appears as shown in Figure 4-11 for DTMF, the MF Signaling Dial Setup Display appears as shown in Figure 4-12 for MF. To return to the talk setup display, press the SET UP key again.

The dialing operation of the CTS with DTMF or MF selected is the same as for dial pulsing; the "+" key is used for off-hook, and the "-" key is used for on-hook. The tone duration for DTMF digits is 80 milliseconds, and the interdigit interval is 80 milliseconds. The tone duration for MF digits is 75 milliseconds, except for KP1 and KP2 which are 120 milliseconds, and the interdigit interval is 75 milliseconds. The frequency accuracy of the tones is ± 0.7 percent.

The amplitude of the tones is controlled by the send level of the CTS, except during remotely controlled operation, where the DTMF and MF tone level is controlled by the SMFL send level command. The output amplitude of each of the tones is equal and 3 dB below the send level value. The output level accuracy is ± 0.5 dB. The DTMF and MF digits and their tone frequencies are identified in Table 4-2.



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Figure 4-11. DTMF Signaling Dial Setup Display



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Figure 4-12. MF Signaling Dial Setup Display

Table 4-2. DTMF and MF Tone Frequencies

DTMF TONE FREQUENCIES		MF TONE FREQUENCIES	
Digit	Frequencies (Hz)	Digit	Frequencies (Hz)
1	697 + 1209	1	700 + 900
2	697 + 1336	2	700 + 1100
3	697 + 1477	3	900 + 1100
4	770 + 1209	4	700 + 1300
5	770 + 1336	5	900 + 1300
6	770 + 1477	6	1100 + 1300
7	852 + 1209	7	700 + 1500
8	852 + 1336	8	900 + 1500
9	852 + 1477	9	1100 + 1500
*	941 + 1209	0	1300 + 1500
0	941 + 1336	CD11	700 + 1700
#	941 + 1477	CD12	900 + 1700
A	697 + 1633	KP1	1100 + 1700
B	770 + 1633	KP2	1300 + 1700
C	852 + 1633	ST	1500 + 1700
D	941 + 1633		

4.5.2 VF Dial/Talk with Call Progress and Signaling (Option .35A or .35C)

Call Progress and Signaling (Option .35A or .35C) is a complex signaling interface that permits the CTS to direct dial test connections and determine if a call has been routed correctly. Options .35A and .35C handle signaling for loop-start and ground-start 2W systems, and include reverse battery detection and reverse battery wink detection for loop-start systems so equipped.

Call progress detection is particularly useful in REACT 2000 applications where an operator is not present at the CTS to determine if dial tone is present, or if the dialed call encounters a line busy or trunk busy signal.

4.5.2.2 Setup Display

To set up a VF dial/talk measurement, press the DIAL/TALK key in the TEST LINES section of the front panel. With Option .35A or .35C installed, the VF Talk Setup Display appears as shown in Figure 4-14. Status displays are, in general, available by pressing the MEAS key. Pressing the SET UP key returns the user to the setup display. To select the type of dialing, press the first soft key.



Figure 4-14. VF Talk Setup Display (With Call Progress and Signaling)

Dialing Selections: To select the type of dialing, press the first soft key. The dialing choices are DPS, DTMF, or MF.

NOTE: DPS must be selected to perform outpulsing on E & M signaling systems.

Call Progress: CP continuously displays over the second soft key. Pressing the second soft key briefly changes the display to indicate the presence of call progress tones at the TEST LINES NORM-RCV jack. The possible messages are as follows: DIAL TONE, LINE BUSY, TRUNK BUSY, or NO TONE. After a five-second delay, the setup display returns.

2W/4W Selection: The third soft key toggles between 2W and 4W. The setting should be 2W for loop-start and ground-start signaling, and 4W for E & M and SF signaling. In 4W, the receive jack is monitored for the receive signal. In 2W, the send jack is monitored.

Signaling Selection: The fifth soft key, when pressed, steps through choices of LPST (loop-start), GRST (ground-start), E&M1 (E&M type 1), E&M2 (E&M type 2), E&M3 (E&M type 3), E&M4 (E&M type 4),

E&M5 (E&M type 5), SF (for Option .35C), and NONE (for 4W dry circuits with no supervision, such as private line data).

Normal/Reverse Selection: The normal/reverse selection enables the send and receive jacks to be interchanged. For normal line connection, toggle the sixth soft key to select NORM. For reverse line connection, toggle the sixth soft key to select REV.

NOTE: Normal 4W line connection is talk on the NORM-SEND (2W) jack, and listen on the NORM-RCV jack. Normal 2W connection is talk/listen on the NORM-SEND (2W) jack. Reverse 4W line connection is talk on the NORM-RCV jack, and listen on the NORM-SEND (2W) jack.

Hold Control: Hold circuits are provided for both the NORM-SEND (2W) jack and the NORM-RCV jack. The hold soft key controls these circuits except during dial/talk. If dial/talk is active, then the hold circuit for the selected jack is controlled by the "+" and "-" keys on the keypad, or by the hook switch on an external handset if one is installed in the DIAL/TALK jack. The selected line is the NORM-SEND (2W) jack for the NORM selection, and the NORM-RCV jack for the REV selection. The jack not selected is always controlled by the hold soft key.

To activate the hold function, press the seventh soft key. HOLD appears in uppercase letters, indicating that the hold function is active. To toggle the function off, press the soft key again. Hold appears in lowercase letters, indicating that the function is off.

NOTE: The hold function is not available if NONE or E & M are selected in the talk setup display.

4.5.2.3 Measurement Displays

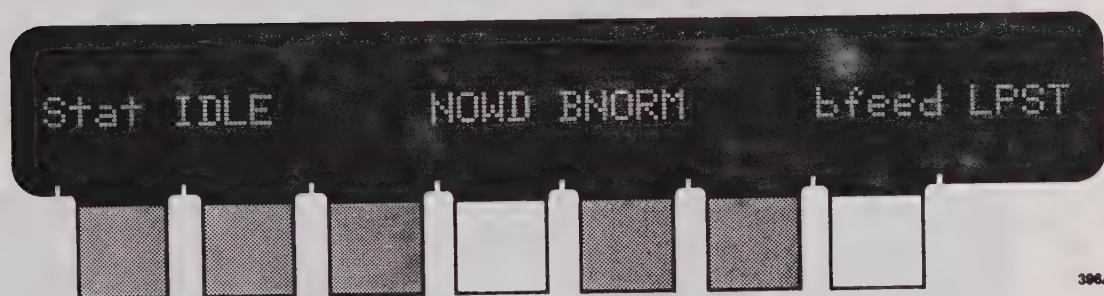
From the VF Talk Setup Display (with Call Progress and Signaling), you can access the following measurement displays by pressing the MEAS key:

- Loop-Start Signaling Measurement Display
- Ground-Start Signaling Measurement Display
- E & M Signaling Measurement Display
- SF Signaling Measurement Display.

Loop-Start Signaling

The Loop-Start Signaling Measurement Display is shown in Figure 4-15.

Manual dialing may be initiated from this display by connecting the 2W line to the TEST LINES NORM-SEND jack in parallel with the 2W T₁ and R₁ terminals on the SIGNALING rear-panel barrier strip. Press the "+" button on the keypad to seize the line, and listen for dial tone with the MONITOR switch in the SEND position. Also note that the supervision status changes from IDLE to BUSY. The desired phone number may be dialed on the keypad, using the dialing method previously selected in the setup display. Automatic dial may also be used to perform this function. When the call is complete, press the "-" key on the keypad to terminate the call.



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Figure 4-15. Loop-Start Signaling Measurement Display

Supervision Status: The supervision status above the second soft key indicates BUSY or IDLE, depending on the status of the line connected to the 2W T₁ and R₁ terminals on the SIGNALING rear-panel barrier strip.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key, changing NOWD (no wink detection) to WNKD (wink detection). When the CTS executes a line seizure (by pressing the "+" key), the reverse battery wink detector activates and the appropriate message displays for a five-second period after the line is seized. The possible messages are SHORT WINK, WINK, OFF HOOK, or NO DETECTION. If SHORT WINK, OFF HOOK, or NO DETECTION occur, the CTS returns to the on-hook state.

Battery Polarity: Above the fifth soft key is the status for the polarity of the circuit applied to the tip and ring inputs. BNORM indicates that the station battery polarity is normal. BREV indicates a battery reversal. Some signaling systems use a battery reversal to signal an off-hook condition at the distant end.

Battery Feed Enable: The seventh soft key enables the battery feed circuit to supply talk battery on a local loop. When the BFEED label is in uppercase letters, the function is enabled.

Ground-Start Signaling

The Ground-Start Measurement Display is shown in Figure 4-16.

A ground-start circuit can be seized by first examining the BUSY/IDLE supervision status to determine whether the line is active, then activating the TGND detector and turning RGND on. The supervision status indicator should change from OPEN to GND to indicate a response from the central office. To disable RGND, press the fifth soft key once more.



Figure 4-16. Ground-Start Signaling Measurement Display

Supervision Status: The supervision status above the second soft key indicates BUSY or IDLE if LOOP detection is selected, and GND or OPEN if TGND (tip ground) detection is selected.

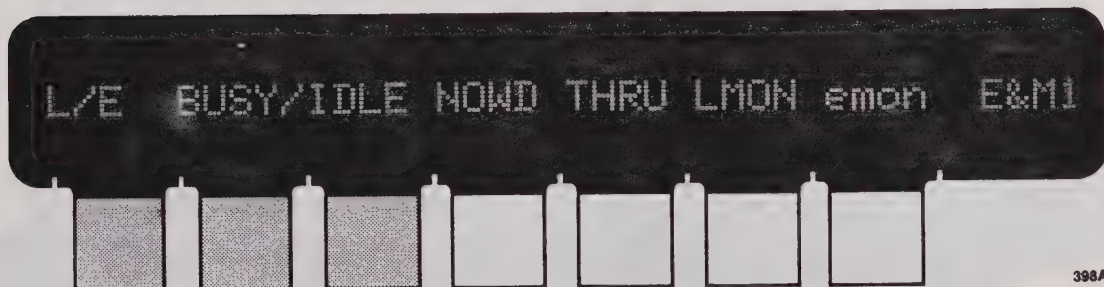
Detection Selection: To select LOOP detection, press the third soft key so that loop changes to uppercase characters. To select TGND (tip ground) detection, press the fourth soft key to turn TGND on.

Ring Ground Control: To apply a ring ground to the ground-start circuit, press the fifth soft key to change rgnd to uppercase characters. To release the ring ground, press the fifth soft key again.

Battery Feed Enable: The seventh soft key enables the battery feed circuit to supply talk battery on a local loop. When the BFEED label is in uppercase characters, the function is enabled.

E & M Signaling

The measurement displays for all types of E & M signaling are similar, so this section applies to E & M signaling types 1 through 5. The E & M Signaling Measurement Display is shown in Figure 4-17.



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Figure 4-17. E & M Signaling Measurement Display

Connections: E & M signaling leads are connected to the SIGNALING rear-panel barrier strip, observing the line (facility) and equipment (drop) directions. The E & M leads are normally through connected, and THRU displays above the fifth soft key until a SPLIT command is selected. To properly seize an E & M circuit requires station battery and ground connections at the SIGNALING rear-panel barrier strip.

Supervision Status: The supervision status above the second soft key indicates BUSY or IDLE for the received status of the E lead from the line direction. The supervision status above the third soft key indicates BUSY or IDLE for the received status of the M lead from the equipment direction.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key, changing NOWD to WNKD.

Monitor and Control Selection: The fifth soft key, when pressed, toggles between THRU and SPLT (split). When THRU is selected, the displays above the sixth and seventh soft keys indicate the direction monitored for dial pulses, either equipment or line. The direction is chosen by pressing the associated soft key. When SPLT is selected, displays above the sixth and seventh soft keys change to LREL (line side released) and EREL (equipment side released), respectively.

When the soft keys below LREL and EREL are pressed and wink detection is enabled, the measurement display blanks momentarily and then returns with the wink message is SHORT WINK, WINK, OFF HOOK, or NO DETECTION. After a five-second delay, the measurement display returns. The display indicates LSEZ (line side seized) or ESEZ (equipment side seized) above the sixth and seventh soft keys, showing the circuit has been seized in that direction. For dial pulse decoding purposes, the last direction which is seized is monitored for dial pulses.

SF Signaling

The SF Signaling Measurement Display is shown in Figure 4-18.



975

Figure 4-18. SF Signaling Measurement Display

Supervision Status: The supervision status above the second soft key shows sf in lowercase letters for the absence of the tone or busy, and SF in uppercase letters for the presence of tone or idle.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key, changing NOWD to WNKD. Wink detection is keyed to the transition of supervision status from idle to busy.

Send Side Condition: Above the fifth and sixth soft keys is the status of the SF supervision on the send side. Idle condition is indicated with ON,

and 2600-Hz tone appears on the send side. Busy is indicated with OFF, and no tone appears on the send side. Control of the supervision is performed with the keypad "+" and "-" keys. The "-" key results in an immediate idle condition; the "+" key causes off-hook, and initiates dialing if automatic dial is set. The transmit level of the SF tone is initially 8 dB below the send level set in the Send Setup Display, and then remains at 20 dB below the send level. The higher level is also used during pulsed SF dialing.

4.5.2.4 Address Digit Receive Display

The Option .35C provides central office quality detection of DTMF and MF tones, and dial pulses. The Option .35A provides only DTMF tone detection. Address signaling tones and pulsing are detected in dial/talk mode only. To receive digits, press the DIAL/TALK key and then the SET UP key three times to show the Address Digit Receive Setup Display shown in Figure 4-19.



976

Figure 4-19. Address Digit Receive Setup Display

Tone and Pulse Selection: For Option .35C, the first soft key selects the type of digits to be detected; dial pulse, or DTMF or MF tones. For Option .35A, DTMF always displays, and the soft key does not function.

Digit Buffer Clear: The second soft key clears the 40-digit receive buffer.

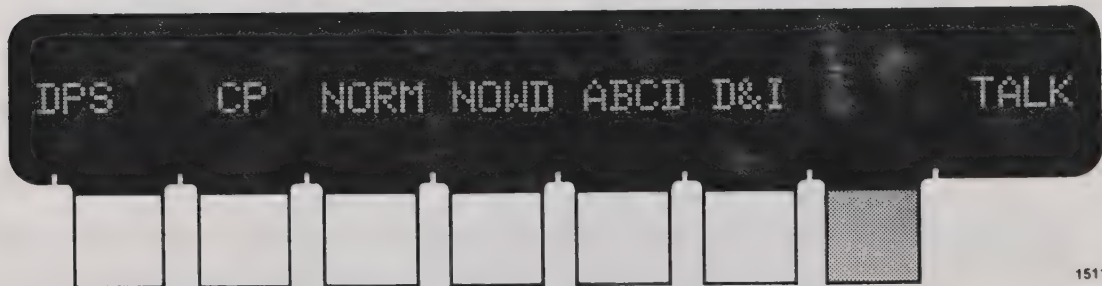
Display Line Selection: The third soft key allows the display of digits up to the maximum capacity of 40 digits. There are 20 digits in each of the two display lines; the first line is always filled first. The twenty-first digit causes the display to advance to the second line. Clearing the buffer returns the display to the first line. Digits received beyond the 40-digit limit overwrite the fortieth digit.

4.5.3 PCM Dial/Talk

The CTS provides the same dial/talk capabilities on a PCM channel as it does on the VF line. In addition, the CTS performs SF detection and generation, and FXS and FXO signaling and control functions.

The following is an example procedure to dial and talk on a PCM channel:

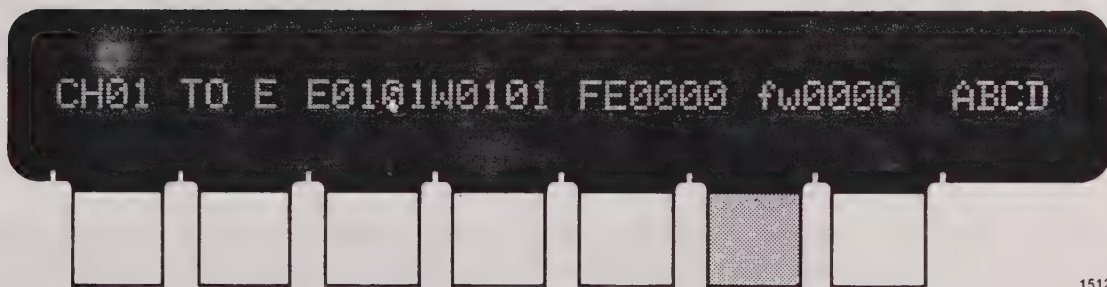
Step	PCM Dial/Talk Example
1	Press the PCM key, then the second soft key. The PCM LED lights.
2	Press the DIAL/TALK key. The PCM Dial/Talk Setup Display appears as shown in Figure 4-20.
3	Press the first soft key to select DPS, DTMF or MF dialing.
4	Press the third key to select the type of signaling, either normal (NORM), FX office loop-start (FXOLS), FX office ground-start (FXOGS), FX station loop-start (FXSLS), or FX station ground-start (FXSGS).
5	Press the fourth soft key to enable wink detection (WNKD) or no wink detection (NOWD).
6	Press the fifth soft key to select robbed-bit signaling or SF signaling.
7	To listen on the channel, press the sixth soft key to select monitor (MON in inline or DCS modes) or idle (IDLE in terminal mode).



1511

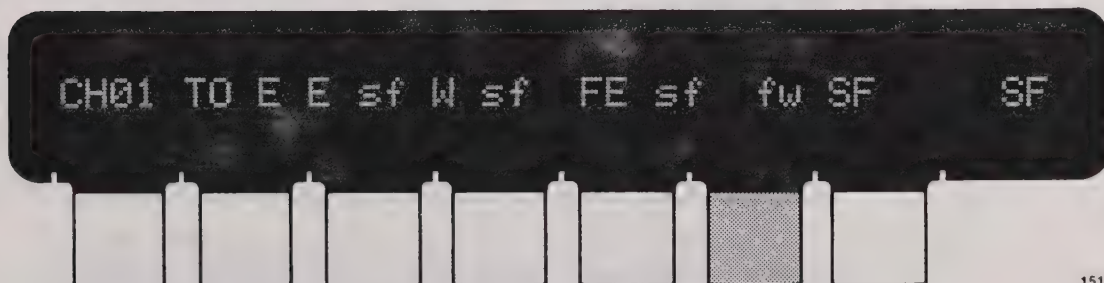
Figure 4-20. PCM Dial/Talk Setup Display (With Call Progress and Signaling)

Step	PCM Dial/Talk Example (continued)
8	To control, talk, and dial on a channel, press the sixth soft key to select drop-and-insert (D&I). When D&I is selected, the channel is taken out of service and it is then possible to talk on the channel.
9	For DCS mode, proceed to Step 14. For inline and terminal modes, press the MEAS key in the DISPLAY section of the front panel. Refer to Figure 4-21 for the robbed-bit signaling measurement display, and Figure 4-22 for the SF signaling measurement display.



1512

Figure 4-21. Inline and Terminal PCM Dial/Talk Robbed-Bit Measurement Display



1513

Figure 4-22. Inline and Terminal PCM Dial/Talk SF Measurement Display

Step	PCM Dial/Talk Example (continued)
10	The first soft key is used with the keypad to select the channel number from 01 through 24. Select the appropriate channel number.
11	The second key is used to select the drop-and-insert "to" direction, which can be east (e), west (w), or if in the inline conference mode, both directions simultaneously. Select the appropriate direction. <i>NOTE: You cannot dial in conference once the connection is made, only talk and listen. Lowercase letters indicate monitor or idle; uppercase letters indicate drop-and-insert.</i>
12	The third and fourth keys are used with the keypad to enter the robbed-bits transmitted during drop-and-insert in the east and west directions. Set the A and B bits for superframe, and the ABCD bits for ESF in the unused direction to the state desired (idle or busy), so that when D&I is active, the channel signaling is properly conditioned. The third and fourth soft keys can also be used to set the state of SF signaling in the unused direction during drop-and-insert. When D&I is active, uppercase SF indicates that tone is on or idle, and lowercase sf indicates that no tone or busy is transmitted.
13	The two areas of the display above the fifth and seventh soft keys show the status of the receive PCM in each direction, or the receive signaling state of the robbed-bits or the SF detector. Uppercase letters indicate the selected "from" direction. If there is a loss of signal (NOPCM), or remote frame alignment alarm (RFALM), they are displayed; otherwise, the signaling state appears. <i>NOTE: Selection of a "to" direction also selects the same "from" direction.</i>
14	For DCS mode, press the MEAS key in the DISPLAY section of the front panel. Refer to Figure 4-23 for robbed-bit signaling and Figure 4-24 for SF signaling.
15	The first soft key is used with the keypad to select the test port number from 01 through 12. Select the appropriate test port number.
16	The second soft key is used to select the drop-and-insert "to" direction, which can be odd (O), even (E), or conference (CONF) which is both directions simultaneously. Select the appropriate direction. <i>NOTE: You cannot dial in conference once the connection is made, only talk and listen. Lowercase letters indicate monitor or idle; uppercase letters indicate drop-and-insert.</i>

Step

PCM Dial/Talk Example (continued)

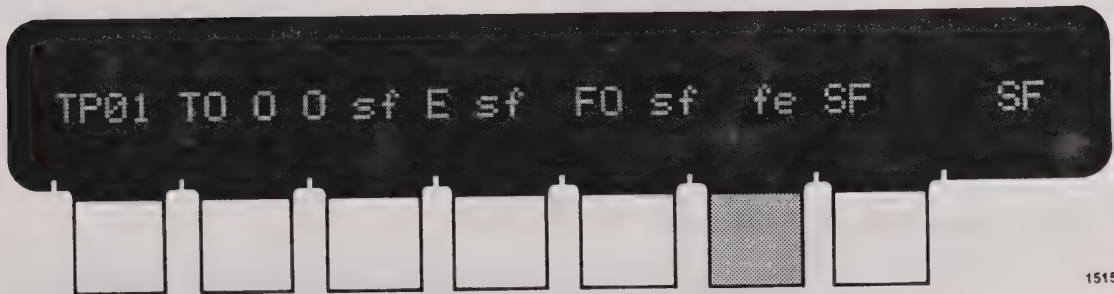
17

The third and fourth keys are used to enter the signaling bits transmitted during drop-and-insert (D&I) in the odd and even directions. Set the A and B bits for superframe and ABCD bits for ESF in the unused direction to the state desired (idle or busy), so that when D&I is active, the channel signaling is properly conditioned. The third and fourth soft keys can also be used to set the state of SF signaling in the unused direction during drop-and-insert. When D&I is active, SF indicates that tone or idle is transmitted, while lowercase sf indicates that no tone or busy is transmitted.



1514

Figure 4-23. DCS PCM Dial/Talk Robbed-Bit Measurement Display



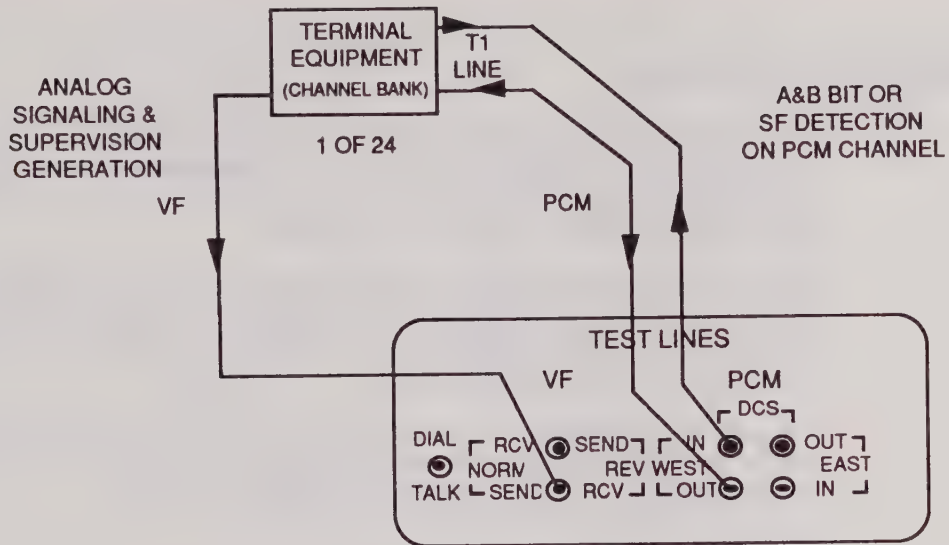
1515

Figure 4-24. DCS PCM Dial/Talk SF Measurement Display

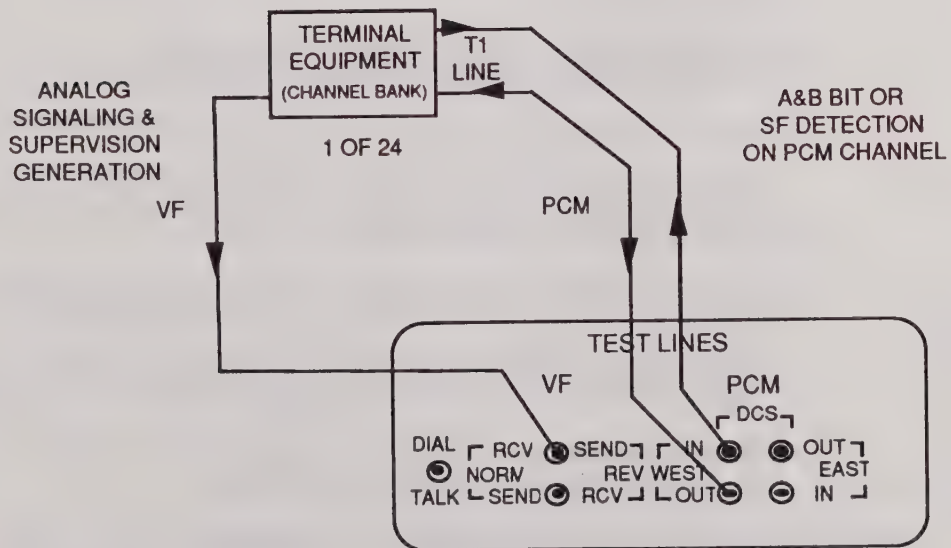
Step	PCM Dial/Talk Example (continued)
18	The two areas of the display above the fifth and seventh soft keys show the status of the receive PCM in each direction, or the receive signaling state of the robbed-bits or the SF detector. Uppercase letters indicate the selected "from" direction. If there is a loss of signal (NOPCM), remote frame alignment alarm (RFALM), or AIS (all ones), they are displayed; otherwise, the signaling state appears. <i>NOTE: Selection of a "to" direction also selects the same "from" direction.</i>
19	The CTS is now ready to seize the channel. This is accomplished by pressing the SET UP key which returns you to the PCM dial/talk setup display, pressing the sixth soft key to enter drop-and-insert (D&I), and pressing the MEAS key.
20	Press the "+" key on the keypad and listen for a dial tone on the MONITOR speaker. You are now off-hook in the selected "to" direction. If wink detection was selected (WNKD), the detection report appears on the left half of the display. The results can be any of the following: WINK, OFF HOOK (glare), or NO DETECTION (on-hook). If OFF HOOK or NO DETECTION is present, the CTS returns ton-hook.
21	Enter the number to be dialed through the keypad and, if necessary, enter the auxiliary characters for DTMF and MF by pressing the SET UP key. Once the connection is made, the TO/FROM/TALK switch may be depressed to talk, and released to listen. Set the MONITOR control to a comfortable listening level. To talk, speak into the MONITOR speaker.
22	If it is necessary to redial, press the "-" key on the keypad to drop the connection, then press the "+" key and listen for dial tone or watch for a wink detection before dialing.
23	If an external handset is used, connect the handset to the DIAL/TALK jack on the front panel.
24	Use the switch hook control on the handset to go off-hook. Once dial tone is received or wink detection is complete, use the handset to enter the number to be dialed.

4.5.3.1 Terminal Analog Operation

When the terminal test arrangement is selected in PCM, and the PCM to PCM configuration is active, PCM dial/talk functions are performed. If VF to PCM or PCM to VF configurations are selected, VF dial/talk functions may be performed as well as PCM. The typical application for this test arrangement is testing a channel card in a channel bank. (Refer to Figure 4-25.)



VF TO PCM



PCM TO VF

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Figure 4-25. Typical Terminal Dial/Talk Configurations

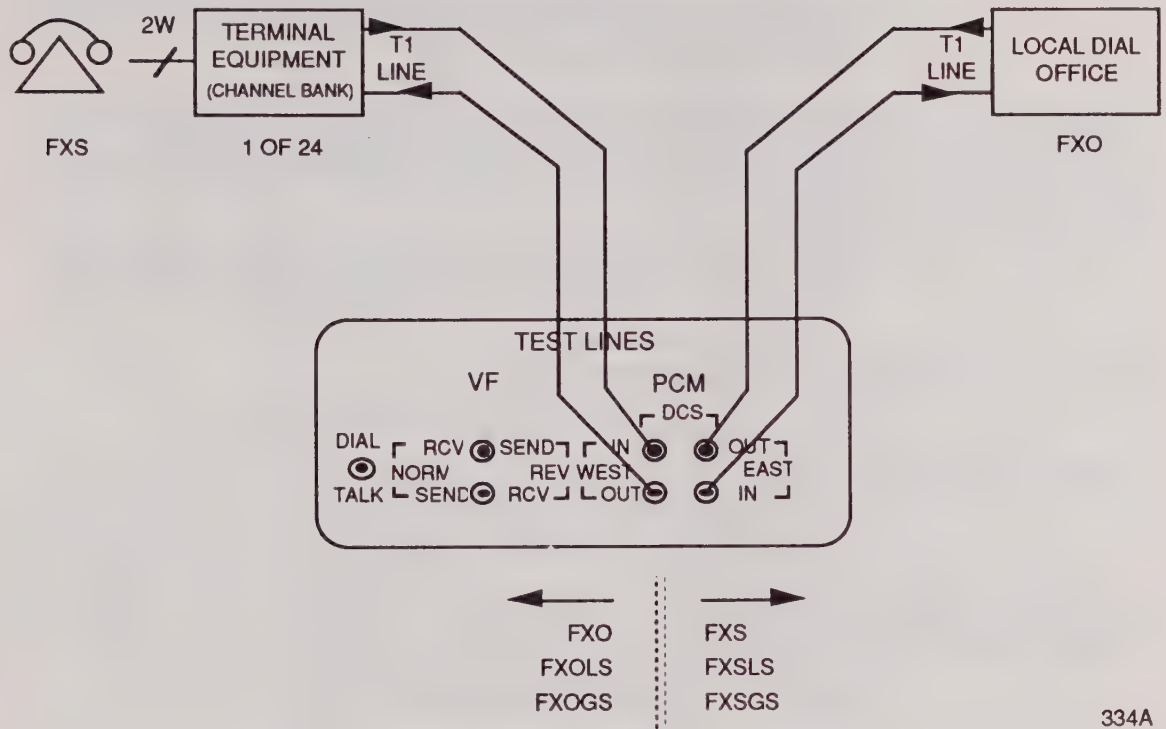
4.5.3.2 FXS and FXO Foreign
Exchange Signaling Sequences

The CTS has sequences for testing both the station and office ends of a foreign exchange circuit on a PCM channel. These sequences exercise the functions of the circuits whether robbed-bit or SF signaling is used, and whether the circuit is ground-start or loop-start.

When testing toward the office, the CTS simulates a station, idling the circuit toward the actual station so that it receives no extraneous ringing. When testing toward the station, the CTS simulates an office, idling the circuit toward the actual office so that no office equipment is tied up.

To perform an FX circuit test with PCM active, press the DIAL/TALK key in the TEST LINES section of the front panel. The following is an example procedure of an FX circuit test with PCM active:

Step	FX Circuit Test With PCM Active
1	Press the third soft key to select the type of FX sequence desired: Foreign Exchange Office Loop-Start (FXOLS) or Ground-Start (FXOGS), or Foreign Exchange Station Loop-Start (FXSLS) or Ground-Start (FXSGS). (see Figure 4-26.)
2	Use the fifth soft key to select the signaling type, either robbed-bit or SF. When ready, select drop-and-insert (D&I) using the sixth soft key.
3	Press the MEAS key to show the PCM dial/talk measurement display.
4	To initiate an FX sequence, press the "+" key on the keypad. This corresponds to initiating a call in the station simulation mode, and ringing a station in the office simulation mode.
5	Correct execution of the FX sequence results in the message SEQUENCE COMPLETE appearing in the left half of the measurement display. a) In the station simulation mode, dialing is enabled. If automatic dial is active, the dial sequence begins. The result should be a connection. b) In the office simulation mode, if the station answers the incoming call, you may then talk and listen using the station.
6	Incorrect execution of the FX sequence terminates the sequence and displays an appropriate message in the measurement display. In the station simulation mode, dialing is inhibited; if automatic dial is active, the dialing sequence is omitted.
7	The sequence may be aborted by pressing the "-" key on the keyboard. This step restores signaling to the initial state for that selected sequence.



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Figure 4-26. Typical PCM Foreign Exchange Testing

FX Office Loop-Start (FXOLS)

The initial state when FXOLS is selected is as follows:

TO	A,B	SF	STATE
office	0,1	on	idle
station	0,1	off	idle

Pressing the "+" key on the keypad begins the FXOLS sequence, causing the following events to occur:

- 1) Line busy (A=1, SF off) from the station is tested. If true, the message LINE BUSY displays, and the sequence terminates from the station.

- 2) If line busy is false, a three-ring sequence initiates by setting the B bit to 0 or SF on for two seconds, and then setting the B bit to 1 or SF off for four seconds, repeated three times.
- 3) If line busy from the station becomes true (A=1, or SF off), ringing stops and off-hook (B=1) is sent to the station. The message SEQUENCE COMPLETE appears, and you may talk/listen to the station.
- 4) If the station remains idle (A=0, SF on) during the three-ring cycles, the message NO ANSWER appears, and the sequence terminates.

FX Office Ground-Start (FXOGS)

The initial state when FXOGS is selected is as follows:

TO	A,B	SF	STATE
office	0,1	on	idle
station	0,1	on	idle

Pressing the "+" key on the keypad begins the FXOGS sequence, causing the following events to occur:

- 1) Ring ground (B=0, SF off) from the station is tested. If ring ground is true, the message RING GROUND displays, and the sequence terminates.
- 2) If at anytime ring ground from the station is false, then line busy (A=1, B=1, SF off) is tested. If true, the message LINE BUSY displays, and the sequence terminates.
- 3) If line busy from the station is false, a three-ring sequence begins by setting the B bit to 0 or pulsing SF on for two seconds, and then setting the B bit to one or SF off for four seconds, repeated three times.
- 4) If at anytime line busy from the station becomes true (A=1, or SF off), then ringing stops, and off-hook (B=1, SF off) is sent to the station. The message SEQUENCE COMPLETE appears, and you may talk/listen to the station.
- 5) If the station remains idle (A=0, B=1, SF on) during the three-ring cycles, the message NO ANSWER appears, and the sequence terminates.

FX Station Loop-Start (FXSLS)

The initial state when FXSLS is selected is as follows:

TO	A,B	SF	STATE
office	0,1	on	idle
station	0,1	off	idle

Pressing the "+" key on the keypad begins the FXSLS sequence, causing the following events to occur:

- 1) Five seconds are spent looking for incoming ring (B=0, SF on) from the office. If true, the message INCOMING RING displays, dialing is blocked, and the sequence terminates.
- 2) If there is no incoming ring detected for five seconds, then off-hook (A=1, B=1, SF off) is sent to the office, and the message SEQUENCE COMPLETE displays. Dialing is permitted, and if automatic dial is active, the dial sequence begins.

FX Station Ground-Start (FXSGS)

The initial state when FXSGS is selected is as follows:

TO	A,B	SF	STATE
office	0,1	on	idle
station	0,1	off	idle

Pressing the "+" key on the keypad begins the FXSGS sequence, causing the following events to occur:

- 1) Incoming ring is tested from the office. For SF signaling, this is up to a five-second sequence of looking for SF pulsed at 20 Hz, with two seconds pulsed on and four seconds off. For robbed-bit signaling, this involves checking for B=0 from the office. If true, then the message INCOMING RING displays, dialing is blocked, and the sequence terminates.

- 2) If incoming ring is false, then line busy from the office is tested (A=0, SF off). If true, the message LINE BUSY displays, dialing is blocked, and the sequence terminates.
- 3) If the office is found to be in the idle state (A, B=1, 1; SF on), ring-ground at the station is simulated by setting A, B=0, 0 or SF off to the office. If the office responds with line busy (A, B=0, 1; SF off), then the message SEQUENCE COMPLETE displays, dialing is permitted, and if automatic dial is active, the dial sequence begins.
- 4) If the office remains idle (A, B=1, 1; SF on), then the message NO TIP GROUND displays, dialing is blocked, and the sequence terminates.

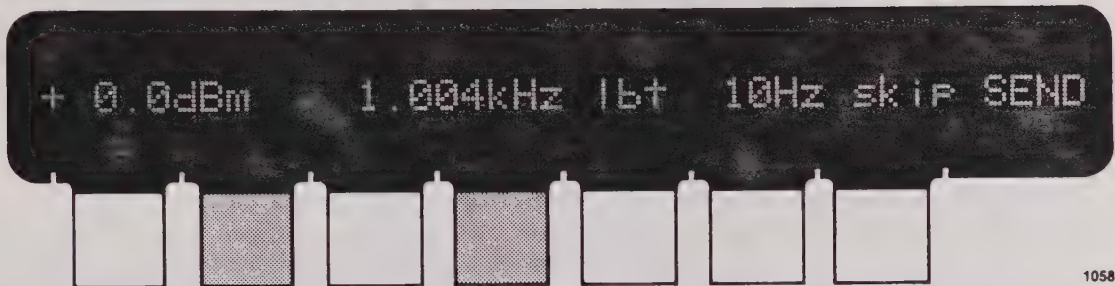
4.6 Signal Generator

This section describes the send level, send frequency and sweep setup procedures for the CTS. The GENERATOR section of the front-panel controls the level of all internally generated test signals, and the frequency of the sine-wave generator. A QUIET TERM key allows quieting of the send signal with a single key press. A fixed level/frequency key for 1004-Hz test tone at -16 dBm is provided to permit activation of the standard test tone. The flexible sweep capability allows for attenuation distortion and delay distortion versus frequency measurements.

4.6.1 Send Setup Display

By pressing the SEND key, the Send Setup Display appears as shown in Figure 4-27. This display allows setting of the generator parameters using the soft keys and ENTER keypad. This can be done while another generator function is active, with the exception of setting frequency during a sweep. The $\text{FREQ}\uparrow$ and $\text{FREQ}\downarrow$ keys adjust the programmable generator output up or down in 1, 10, 100-Hz, 1-kHz and, with Option .10, 10-kHz steps.

NOTE: During a sweep, the SEND display shows the active sweeping send frequency.



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Figure 4-27. Send Setup Display

Send Level Selection: To set the send level, press the first soft key. Enter the sign of the level to be entered and then most-through-least significant digits through the keypad. Levels of +10.0 through -70.0 dBm may be entered.

Send Frequency Selection: To set the generator send frequency, press the third soft key. Enter the most-through-least significant digits through the keypad. Frequencies from 0.044 through 20.004 kHz (to 120.004 kHz with Option .10) may be entered.

Loop-back Tone Activate: To send the 829 loop-back tone of 2713 Hz, press the fifth soft key. The tone transmits at the set send level for two seconds or for as long as the key is depressed, whichever is longer. If QUIET TERM is set, it is released for the duration of the tone.

Send Frequency Step Size Selection: To select the send frequency step size, press the sixth soft key. The available selections are 1 Hz, 10 Hz, 100 Hz, 1 kHz and, with Option .10, 10 kHz. All step sizes above 1 Hz include a 4-Hz offset.

SF Skip Selection: To activate generator SF skip, press the seventh soft key. The generator skips frequencies between 2.454 and 2.754 kHz. The SF skip is active when SKIP is all uppercase letters. Pressing the soft key again toggles the selection off.

4.6.2 Sweep Setup Display

Pressing the SWEEP key while the QUIET TERM or 1004 Hz @ -16 dBm is selected causes the Sweep Setup Display to appear as shown in Figure 4-28 but does not initiate a sweep. With the SWEEP LED lit, pressing the SEND key displays the actual sweeping send frequency. To terminate a sweep, press the SWEEP key again, or press the QUIET TERM or 1004 Hz @ -16 dBm key.

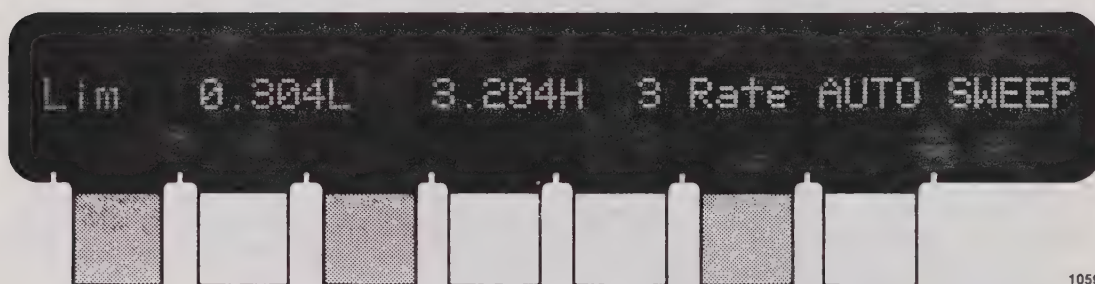


Figure 4-28. Sweep Setup Display

Set Sweep Limits: To set the Lo or Hi sweep limits, press the second or fourth soft key. Enter the most-through-least significant digits of the limit in kHz through the keypad. Limits from 0.04 through 20.00 kHz (through 120.00 kHz with Option .10) may be entered, and the low must always be less than the high.

Sweep Rate Selection: To select the sweep rate, press the fifth soft key. The soft key allows the following selections:

- HI for 3.0 steps per second
- MID for 1.0 steps per second
- LOW for 0.3 steps per second.

Sweep Direction Selection: To select the sweep direction, press the seventh soft key. The following selections are available:

- AUTO for continuous up and down sweeps
- DOWN to sweep from Hi to Lo and stop
- UP to sweep from Lo to Hi and stop.

4.7 VF Testing

4.7.1 Level-Frequency-S/N Measurements

This section describes the procedures for level, frequency and signal-to-noise measurements. The CTS can perform a variety of level measurements while simultaneously displaying a frequency and S/N (signal-to-noise) ratio measurement. All level measurements are made with an averaging detector calibrated to read the rms value for a sine wave. The level measurements are as follows:

- Absolute level measurements in dBm
- Relative level measurement with respect to a TLP (transmission level point), dBm0, or an input level in dB.

Absolute level measurements are made whenever the TLP is set to 0 dBm, and the SET0 function is off. The range of absolute level measurements is +10.0 through -70.0 dBm. Relative measurements with respect to a +10 through -40 dB TLP are made by entering the TLP in the setup display. This function provides up to 40 dB of gain or up to 10 dB of loss to the receive signal. Level measurements relative to an arbitrary receive level in the +10 through -40 dB range are initiated by activating SET0 in the setup display.

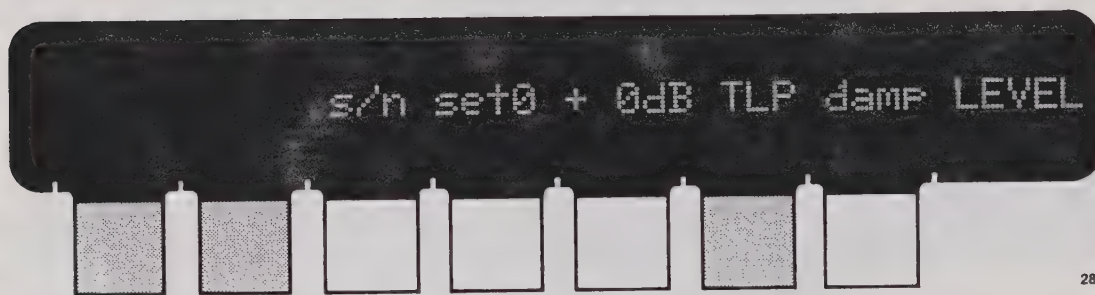
A switchable 60-Hz high pass filter is provided in the level measurement display to determine the effects of 60-Hz components on the level reading. The switch is momentary to prevent erroneous measurements. The filter provides a minimum of 20 dB attenuation at 60 Hz. Extra damping of the receive level measurement may be activated in the level setup. The additional damping may be used to improve the readability of a fluctuating receive level. When not needed, the DAMP control should be off to speed the measurement response time. Damping and S/N ratio measurements may not be simultaneously selected.

Signal-to-noise ratio measurements may be performed along with the level measurements. To perform a signal-to-noise ratio measurement, the distant end must be sending a 1-kHz test tone. The CTS measures the receive level and the 1010-Hz notch noise level, and calculates the ratio of these two signals in dB. The test tone must be in the +10 through -40 dBm level range, and the 1010-Hz notch noise in the 10 through 100 dBmC range. If either component of the measurement is out-of-range, the S/N ratio is displayed as two asterisks (**). For most accurate readings, the TLP should be set so that the relative receive level is approximately 0.0 dBm0.

During level measurements, the monitor signal is obtained directly from the receive signal. The monitor volume control adjusts the listening level for various input levels.

4.7.1.1 Setup Display

To set up a level measurement, press the LEVEL key in the MEASUREMENT section of the front-panel. The Level Setup Display appears as shown in Figure 4-29.



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Figure 4-29. Level Setup Display

S/N Ratio Measurement Selection: To make S/N ratio measurements along with the level and frequency measurements, press the third soft key. The S/N ratio measurement is active if S/N is in all uppercase letters. To toggle it off, press the third soft key again.

NOTE: It is not possible to have both S/N and DAMP selected simultaneously.

Relative Reference Set: To make level measurements relative to a reference point, press the fourth soft key when the received level is at the desired reference point. The level measurements are then made with respect to this reference point. This function is active when SET0 is all uppercase letters. To toggle it off, press the fourth soft key again.

TLP Entry: To enter a TLP for level measurements, press the fifth soft key. Using the keypad, enter a "+" or "-" sign, then the most-through-least significant digits. The TLP may be set between +10 and -40 dB. Enter 0 dB for absolute measurements.

Damping Selection: To reduce level fluctuations on a noisy receive signal, press the seventh soft key. The high damping mode is selected when DAMP is all uppercase letters; to toggle it off, press the seventh soft key again.

NOTE: It is not possible to select both DAMP and S/N simultaneously.

4.7.1.2 Measurement Display

To perform a level measurement, press the MEAS key in the DISPLAY section of the front panel. The Level Measurement Display appears as shown in Figure 4-30.

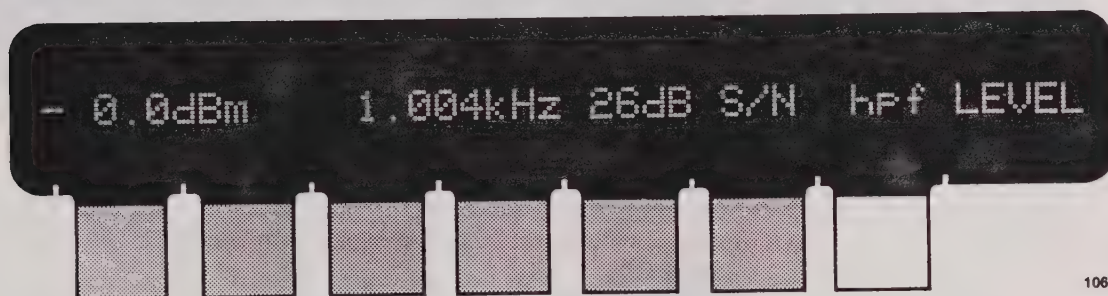


Figure 4-30. Level Measurement Display

Receive Level Measurement Display: The receive level measurement is on the far left of the display. The units of measurement are as follows:

- dBm for absolute level measurements
- dBm0 for level measurements relative to a TLP
- dB for level measurements relative to a reference level.

Receive Frequency Measurement Display: The frequency measurement display follows the level measurement and displays in kHz with a resolution of 1 Hz from 0.040 through 20.100 kHz (10 Hz from 20.100 through 120.10 kHz with Option .10). If the receive level is below -51.9 dBm (or -41.9 dBm during an impulse noise or hits test), the digits of the frequency display are replaced by an asterisk (*).

S/N Ratio Measurement Display: The S/N ratio measurement follows the frequency measurement. The S/N ratio displays in dB. The CTS must be receiving a 1-kHz test tone for this measurement.

High Pass Filter Selection: To insert the 60-Hz high pass filter, press the seventh soft key. The switch must be held down until the reading stabilizes. The filter causes at least 20 dB attenuation at 60 Hz.

4.7.2 Noise Measurements

The CTS uses an rms responding detector to perform, the following types of noise measurements:

- Absolute noise measurements
- Noise measurements relative to a TLP (transmission level point)
- Absolute noise-to-ground measurements
- Noise-to-ground measurements relative to a TLP.

The following filters are available for weighting the receive signal:

- C-Message filter
- 3-kHz flat filter
- 1010-Hz test tone notch filter
- Option .15 noise filters (if installed)
 - 15-kHz flat
 - Program
- Option .15B noise filters (if installed)
 - 15-kHz flat
 - 50 kilobit
- Option .15C noise filters (if installed with Option .10 only)
 - 15-kHz flat
 - 50 kilobit
 - 50-kHz flat.

Absolute noise measurements are made whenever the TLP is set to ± 0 dB. The range of the absolute noise measurements is 10 through 100 dBm, 20 through 100 dBm for Option .10. Relative measurements with respect to a TLP are made by entering a TLP in the +10 through -40 dB range in the setup display.

Provision is made for extra damping of the receive noise measurement, which may be activated in the noise setup. The additional damping may be used to improve the readability of a fluctuating noise measurement. When not needed, the DAMP control should be off to speed up the measurement response time.

Noise-to-ground measurements are made by selecting NTG in the noise measurement. When NTG is active, the receive side is configured for noise-to-ground measurements with the appropriate noise weighting filters selected. When making low level noise or noise-to-ground measurements, the generator should be in quiet termination. This is done by pressing the QUIET TERM key in the GENERATOR section of the front panel.

4.7.2.1 Setup Display

To set up a noise measurement, press the NOISE key in the MEASUREMENT section of the front-panel. The Noise Setup Display appears as shown in Figure 4-31.



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Figure 4-31. Noise Setup Display

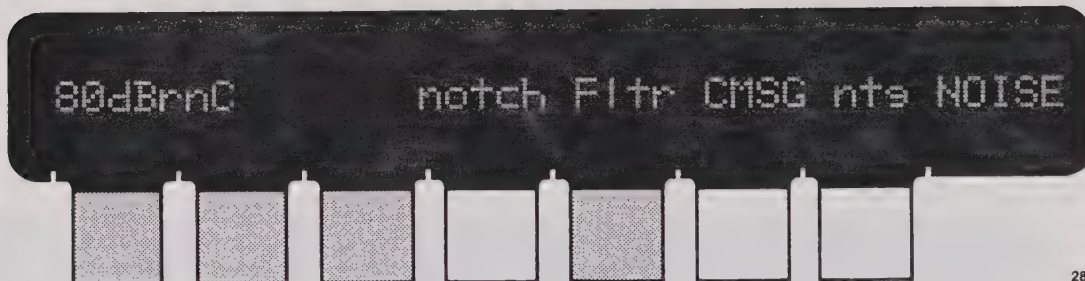
Monitor Selection: During noise measurements, the monitor signal may be obtained directly from the receive signal or from the leveled and weighted receive signal to aid in identifying the noise components. To select the leveled and weighted receive signal, press the second soft key until AGC appears. To return to monitoring the receive signal directly, toggle the second soft key to RCV.

TLP Entry: To enter a TLP for noise measurements, press the fifth soft key. Using the keypad, enter a "+" or "-" sign, then the most-through-least significant digits. The TLP may be set between +10 and -40 dB. Enter 0 dB for absolute noise measurements.

Damping Selection: To reduce noise fluctuations, press the seventh soft key. The high damping mode is selected when DAMP is all uppercase letters; to toggle it off, press the seventh soft key again.

4.7.2.2 Measurement Display

To perform a noise measurement, press the MEAS key in the DISPLAY section of the front panel. The Noise Measurement Display appears as shown in Figure 4-32.



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Figure 4-32. Noise Measurement Display

Receive Noise Measurement Display: The receive noise measurement display is on the far left side of the display. The units of measurements are as follows:

- dBrnC, dBrn for weighted noise measurements
- dBrnC0, dBrn0 for noise measurements relative to a TLP.

1010-Hz Notch Filter Selection: To insert the 1010-Hz notch filter in the noise measurement path, press the fourth soft key below notch. The notch filter is used with all noise-with-tone measurements. To toggle the filter off, press the soft key again.

Noise Weighting Filter Selection: To select a noise weighting filter, press the sixth soft key. The unit toggles through the available filters which may include the following:

- CMSC for C-message
- FLAT for 3-kHz flat
- PRGM for program (requires Option .15)
- 15FLAT for 15-kHz flat (requires Option .15B or .15C)
- 50KBN for 50-kilobit (requires Option .15B or .15C)
- 50FLAT for 50-kHz flat (requires Option .15C and Option .10)

Noise-To-Ground Measurement Selection: To select the noise-to-ground measurement configuration, press the seventh soft key. For noise-to-ground measurements, the display range is +40 through +130 dBrn (+50 through +130 dBrn with Option .10). This measurement is active when NTG is all uppercase letters. To toggle the selection off, press the seventh soft key again.

NOTE: This selection is not available if PCM is on.

4.7.3 Return Loss Measurements

This section describes procedures for return loss measurements, supported by Option .16. Option .16 Return Loss is standard in all CTSs with Revision 12 or greater firmware. This option is designed to perform 2W and 4W return loss measurements in accordance with IEEE Standard 743/Bell PUB 41009. The option contains a generator which allows the measurement of echo return loss (ERL), low frequency singing point return loss (SRLLO), and high frequency singing point return loss (SRLHI). Also provided is an echo suppressor disable tone, which transmits each time the return loss option is activated and each time a front-panel soft key is pressed. The basic unit generator is used for sine wave return loss measurements.

4.7.3.1 Setup Displays

To set up a return loss measurement, press the RTN LOSS key in the MEASUREMENT section of the front panel. For 2W measurements, the line under test must be connected to the NORM-SEND (2W) jack in the TEST LINES section of the front panel. Figures 4-33 and 4-34 show the return loss setup displays.

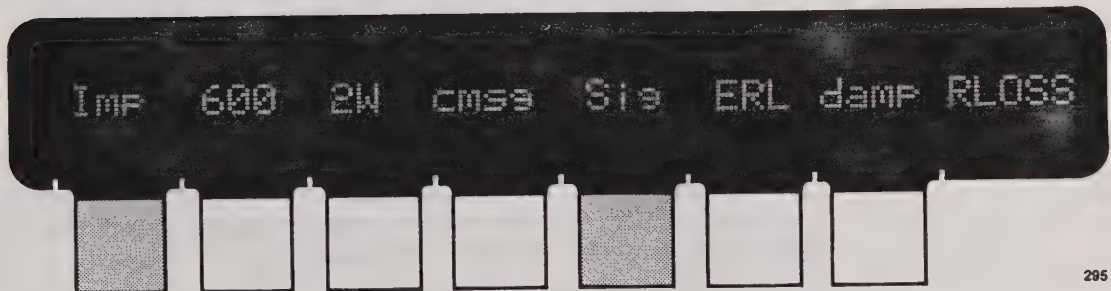


Figure 4-33. Return Loss Setup Display (2W)



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Figure 4-34. Return Loss Setup Display (4W)

2W Reference Impedance Selection: If 2W has been selected, the reference impedance may be selected by pressing the second soft key (see Figure 4-33). The impedance selections are 600, 900, or 1200 Ohms (each in series with 2.16 microfarads); or an external reference impedance which must be inserted into the NORM-RCV jack in the TEST LINES section of the front panel.

NOTE: During all 2W return loss measurements, except for connecting an external reference impedance, the NORM-RCV jack must be open (no connections). Failure to observe this requirement causes errors in the measurements.

4W Transhybrid Loss Correction: If 4W is selected, the transhybrid loss (THL) may be entered for correcting the return loss reading by pressing the second soft key (see Figure 4-34). Use the keypad to enter the sign and then the most-through-least significant digits.

2W/4W Selection: 2W or 4W return loss is selected by pressing the third soft key. The selection toggles between 2W and 4W.

Test Signal Selection: Select the desired test signal by pressing the sixth soft key, to the right of Sig. The selection toggles through the following:

- SRLO for low frequency singing point return loss
- SRHI for high frequency singing point return loss
- ERL for echo return loss
- SINE for sine wave return loss.

Weighting Selection: For the ERL test signal, normal or C-message weighing may be selected by pressing the fourth soft key. If normal weighting is selected, a 60-Hz highpass filter provides flat weighting with

at least 20 dB of loss at 60 Hz. C-message weighting is provided by adding a C-message filter to the 60-Hz highpass filter. If the display indicates CMSG, C-message weighting is selected. If cmsg appears, normal weighting is selected.

Damping Selection: To select standard damping, press the seventh soft key. Standard damping is true when DAMP is all uppercase letters; to return to the fast response, press the soft key again and it toggles off.

NOTE: When standard damping is selected, the reading settling time is significant.

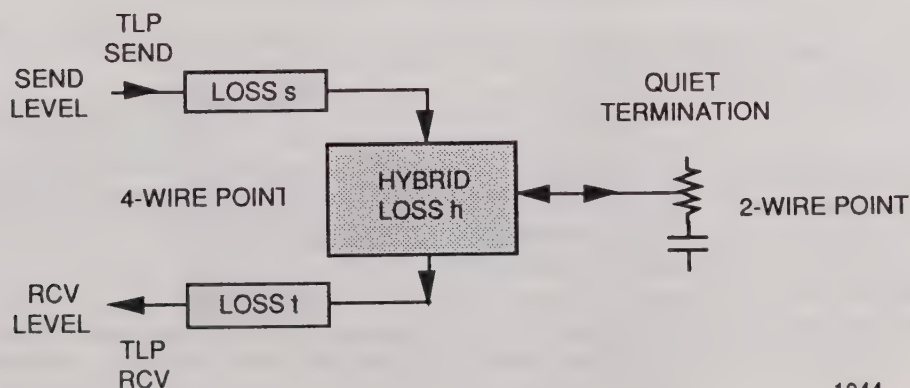
4.7.3.2 2W Return Loss Measurement

To perform a 2W return loss measurement, first select the desired return loss test signal, the desired damping, and the 2W reference impedance. If an external reference impedance is selected, it must be connected across the NORM-RCV jack.

Connect the line under test to the NORM-SEND (2W) jack and then press the MEAS key in the DISPLAY section of the front panel. The distant end of the line under test must be properly connected to a quiet termination.

4.7.3.3 4W Return Loss Measurement

Refer to the following paragraphs and Figure 4-35 for information about the 4W return loss measurement.



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Figure 4-35. 4W Return Loss Measurement Diagram

Echo Path Loss (EPL): Echo path loss is the send level of the weighted noise or sine wave minus the receive level at the 4W point. This measurement displays if the THL register in the setup display is 0.0 dB.

NOTE: The 2W side must be properly terminated during the EPL measurement.

Transhybrid Loss (THL): The transhybrid loss is the difference of the send and receive TLPs at the 4W point.

$$THL = TLP_{SEND} - TLP_{RCV}$$

Equal Level Echo Path Loss (ELEPL): Equal Level Echo Path Loss converts the EPL measurement for transhybrid loss (THL) at the 4W point. This value remains constant at different points along the 4W circuit.

$$ELEPL = EPL - THL$$

Impedance Balance (ZB): Impedance balance is the EPL, less the path losses in the 4W circuit and the hybrid loss, with a total mismatch (the 2W side open or shorted).

$$ZB = EPL - (EPL_0 + s + r + h)$$

where:

EPL = echo path loss, 2W side properly terminated
 EPL₀ = echo path loss, 2W side terminated in an open or short
 s = loss on the 4W send side
 r = loss on the 4W receive side
 h = hybrid loss, with a total mismatch on the 2W side

The impedance balance measurement may be made by either of two methods.

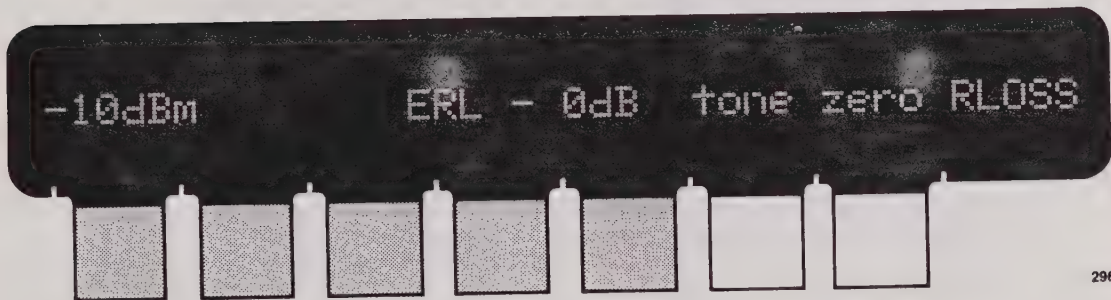
- If coordination at the 2W end is available, then a two-step process is used. First, provide a short or open circuit at the 2W point. The value of EPL₀ is transferred to the THL register and appears in the setup display. Now restore the proper termination at the 2W point. The impedance balance measurement appears in the Return Loss Measurement Display.
- If coordination is not available at the 2W point, as is often the case, but the circuit parameters are known, the measurement may be made with just the EPL measurement. The THL is calculated and entered into the THL register in the return loss setup display by pressing the second soft key from the left, and using the keypad. The sign must be entered first, followed by the number in the range ±99.9 dB. The impedance balance measurement now appears in the return loss measurement display.

NOTE: The 2W side must be properly terminated.

Reference: Notes on the BOC Intra-Lata Networks, TR-NPL000275, Issue 1, April 1986, p. 7-56.

4.7.3.4 Measurement Displays

Figures 4-36 and 4-37 show the return loss measurement displays. The receive level measurement is on the left of the display. Level displays in dBm, and can range from +10 through -80 dBm. Next to the level display is the test signal selected, or as in the case of sine wave return loss, the send frequency in kHz (see Figure 4-37). To the right of the test signal selected is the return loss measurement. Return loss displays in dB of loss.



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Figure 4-36. Return Loss Measurement Display

Echo Suppressor Disable Tone Activation: Pressing the sixth soft key causes a 2.154-kHz echo suppressor disable tone to transmit for one second.

Zero Reference Set: For 4W measurements, with the return loss test signal applied to the circuit and the distant end hybrid disturbed, the transhybrid loss (THL) is set by pressing the seventh soft key. The return loss display reads ± 0 dB. When the hybrid is restored, the return loss reading displays. The THL register may be directly set in the setup display without using the ZERO key, if distant end coordination is not available. The ZERO key is not present for 2W measurements.

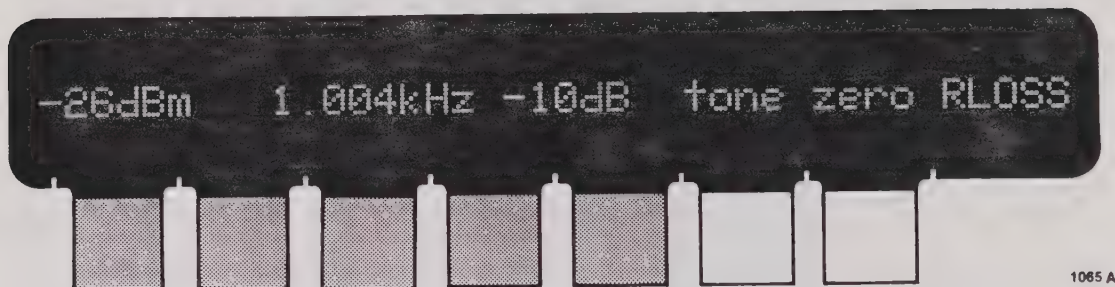


Figure 4-37. Return Loss Measurement Display (4W Sine Wave)

4.8 PCM Testing

This section describes procedures for PCM testing. These procedures are broken down according to the selected test arrangement: inline, terminal, or DCS.

4.8.1 PCM Setup Display 1

To set up a PCM measurement, press the PCM key in the MEASUREMENT section of the front panel. PCM Setup Display 1 appears as shown in Figure 4-38.

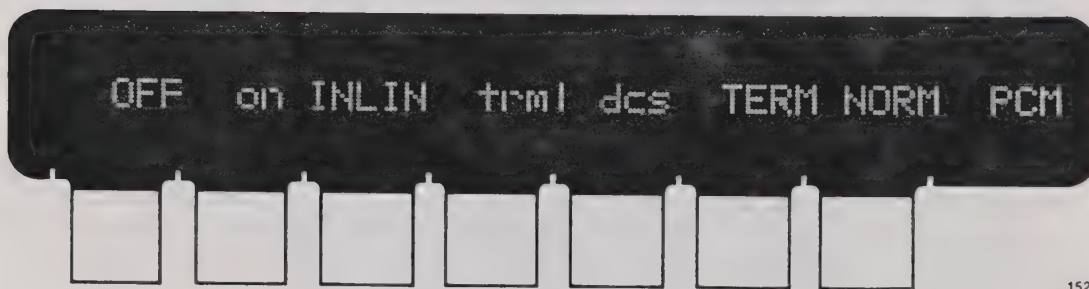


Figure 4-38. PCM Setup Display 1

PCM Option Activation: The first two soft keys activate and deactivate the PCM option. Pressing the second soft key activates the option and lights the LED on the PCM key. Pressing the first soft key deactivates the option, and restores the PCM stream to a pass-through configuration.

Test Arrangement Selection: The third, fourth, and fifth soft keys select the test arrangement for the PCM option. The selections are as follows:

- **INLIN (Inline)** for testing in-service circuits with channels not selected passing through undisturbed
- **TRML (Terminal)** for looped testing of channel banks, with idle channel code (01111111) transmitting through channels not selected
- **DCS** for accessing both circuit directions through a DCS test access digroup (TAD), with ports not selected passing through undisturbed.

PCM Interface Termination Selection: The sixth soft key toggles the receive PCM termination from 100 ohms to bridging (>1000 ohms). In general, TERM should be selected except when monitoring a circuit which is terminated by some other device.

Normal/Advanced Testing Selection: Generally, tests are made in the NORM mode, which provides control and presentation of the commonly used PCM parameters. For advanced testing needs, the ADV selection gains control of additional PCM parameters which are rarely needed in day-to-day testing. For normal testing, press the seventh soft key until NORM appears; for advanced testing, press the seventh soft key until ADV appears.

4.8.1.1 Inline PCM Setup

By pressing the SET UP key with INLIN selected, inline PCM parameters and controls are set up through Inline PCM Setup Display 2 or, if advanced testing is selected, Advanced Inline PCM Setup Display 2. The following paragraphs describe these displays.

Inline PCM Setup Display 2

Figure 4-39 shows Inline PCM Setup Display 2. This display appears if INLIN and NORM are selected through PCM Setup Display 1.

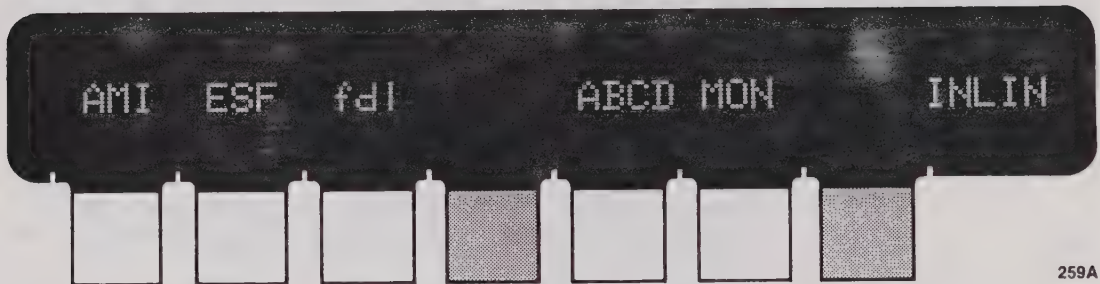


Figure 4-39. Inline PCM Setup Display 2

Zero Substitution Selection: The first soft key selects B8ZS or AMI coding.

- B8ZS (Bipolar Eight Zero Substitution) coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs (bipolar violations) for any string of 8 zeros. B8ZS coding is needed for 64-kbps clear channel operation.
- AMI (Alternate Mark Inversion) coding is a pseudo-ternary signal that conveys binary digits, where successive marks alternate between positive and negative polarity, and a space designates zero amplitude.

NOTE: The line code selection must properly match the line code of the circuit under test or errors (both bit and BPVs) may be injected into the signal in the inline or DCS test arrangement.

Framing Format Selection: The second soft key selects common framing formats. The choices are D1D, D2, D3D4, ESF, and SL96 (SLC-96).

NOTE: The SLC-96 format is supported only in the inline test arrangement.

Facility Data Link Drop-and-Insert Control: The third soft key selects through (fdl) or drop-and-insert (FDL) on the facility data link in the selected direction when extended superframe format (ESF) is selected.

Signaling Type Selection: If D1D, D2, or D3/D4 framing format is selected, the fifth soft key selects robbed-bit (A/B or ABCD), SF, or no signaling (NONE) for the PCM channel. If ESF framing format is selected, the fifth soft key selects robbed-bit (ABAB 4-state, ABCD 16-

state, or AAAA 2-state), SF, or no signaling (NONE). If SL96 is selected, then the fifth soft key is disabled, and no signaling (NONE) is selected.

Monitor, Drop-and-Insert, or Pattern Selection: Pressing the sixth soft key toggles the unit between monitor, drop-and-insert, and pattern.

- MON (Monitor) decodes the selected channel and its signaling in either direction for in-service PCM performance testing. Monitor does not disturb traffic or signaling on the channel. In monitor, BPVs that are received are retransmitted. In ESF, the 4-kbps facility data link may be monitored in both directions on the rear-panel 9-pin RS-232-C connectors.
- D&I (Drop & Insert) decodes the selected channel in either direction. The CTS send side is encoded onto the channel in the direction selected. The opposite direction of the channel is encoded with idle channel code. The signaling for the channel, robbed-bit or SF, is under the direct control of the operator. This mode is used for out-of-service testing of the channel. In drop-and-insert, BPVs are removed.
- PTRN (Pattern) activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or on a selected channel if channelized is selected.

Advanced Inline PCM Setup Display 2

Figure 4-40 shows Advanced Inline PCM Setup Display 2. This display appears if INLIN and ADV are selected through PCM Setup Display 1.



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Figure 4-40. Advanced Inline PCM Setup Display 2

Zero Substitution Selection: The first soft key selects B8ZS or AMI coding.

- B8ZS (Bipolar Eight Zero Substitution) coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs (bipolar violations) for any string of 8 zeros. B8ZS coding is needed for 64-kbps clear channel operation.
- AMI (Alternate Mark Inversion) coding is a pseudo-ternary signal that conveys binary digits, where successive marks alternate between positive and negative polarity, and a space designates zero amplitude.

NOTE: The line code selection must properly match the line code of the circuit under test or errors (both bit and BPVs) may be injected into the signal in the inline or DCS test arrangement.

Framing Format Selection: The second soft key selects common framing formats. The choices are D1D, D2, D3D4, ESF, and SL96 (SLC-96).

NOTE: The SLC-96 format is supported only in the inline test arrangement.

Facility Data Link Drop-and-Insert Control: The third soft key selects through (fdl) or drop-and-insert (FDL) on the facility data link in the selected direction when extended superframe format (ESF) is selected.

Thru or Tandem Switch Alarm Selection: The fourth soft key selects the thru or tandem switch alarm modes.

- THRU allows alarms to pass through undisturbed.
- TANDM (Tandom) simulates the response of a tandem office. If a red alarm is received, then AIS is sent downstream and remote frame alignment alarm is sent upstream. The remote frame alignment alarm continues to be generated for 15 seconds after the red alarm condition ends. The red alarm is either a no PCM or a frame alignment alarm.

Signaling Type Selection: If D1D, D2, or D3/D4 framing format is selected, the fifth soft key selects robbed-bit (A/B or ABCD), SF, or no signaling (NONE) for the PCM channel. If ESF framing format is selected, the fifth soft key selects robbed-bit (ABAB 4-state, ABCD 16-state, or AAAA 2-state), SF, or no signaling (NONE). If SL96 is selected, then the fifth soft key is disabled, and no signaling (NONE) is selected.

Monitor, Drop-and-Insert, or Pattern Selection: Pressing the sixth soft key toggles the unit between monitor, drop-and-insert, and pattern.

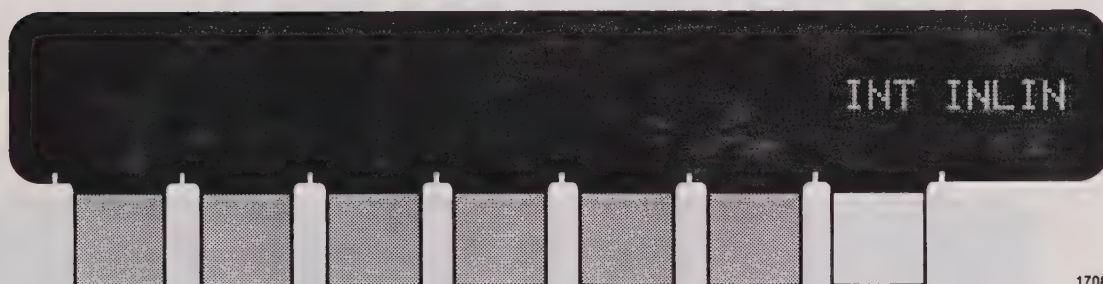
- MON (Monitor) decodes the selected channel and its signaling in either direction for in-service PCM performance testing. Monitor does not disturb traffic or signaling on the channel. In monitor,

BPVs that are received are retransmitted. In ESF, the 4-kbps facility data link may be monitored in both directions on the rear-panel 9-pin RS-232-C connectors.

- D&I (Drop & Insert) decodes the selected channel in either direction. The CTS send side is encoded onto the channel in the direction selected. The opposite direction of the channel is encoded with idle channel code. The signaling for the channel, robbed-bit or SF, is under the direct control of the operator. This mode is used for out-of-service testing of the channel. In drop-and-insert, BPVs are removed.
- PTRN (Pattern) activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or on a selected channel if channelized is selected.

Advanced Inline PCM Setup Display 3

Pressing the SET UP key while in Advanced Inline PCM Setup Display 2 causes Advanced Inline PCM Setup Display 3 to appear as shown in Figure 4-41.



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Figure 4-41. Advanced Inline PCM Setup Display 3

The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals.

- INT (Internal) allows the encoded signal to come from the CTS internal generator, and the decoded signal to be routed through the analog measurement circuitry.
- EXT (External) allows the encoded signal to come from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal to be transmitted through the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS performs as a drop-and-insert

box which may be used to connect external VF test equipment to a PCM channel.

NOTE: In the EXT selection, accurate level results are obtained when the send and receive impedances are set to 600 in the line setup.

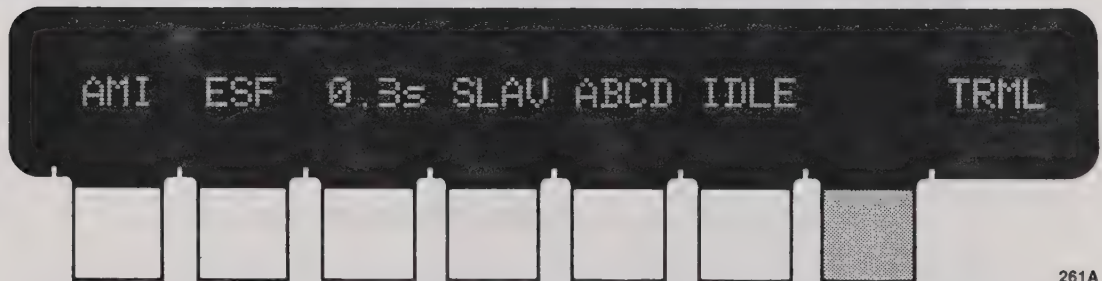
4.8.1.2 Terminal PCM Setup

By pressing the SET UP key with TRML selected, terminal PCM parameters and controls may be set up through Terminal PCM Setup Displays 2 and 3, or if advanced testing is selected, Advanced Terminal PCM Setup Display 2 and 3. The following paragraphs describe these displays:

NOTE: In the terminal mode, the facility data link is always in the drop-and-insert mode if the extended superframe format (ESF) is selected. With no connection at the rear plate, all ones is transmitted unless the remote frame alignment alarm (yellow) is required.

Terminal PCM Setup Display 2

Figure 4-42 shows Terminal PCM Setup Display 2. This display appears if TRML and NORM are selected through PCM Setup Display 1.



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Figure 4-42. Terminal PCM Setup Display 2

Zero Substitution Selection: The first soft key selects B8ZS or AMI coding.

- B8ZS (Bipolar Eight Zero Substitution) coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs (bipolar

violations) for any string of 8 zeros. B8ZS coding is needed for 64-kbps clear channel operation.

- AMI (Alternate Mark Inversion) coding is a pseudo-ternary signal that conveys binary digits, where successive marks alternate between positive and negative polarity, and a space designates zero amplitude.

Framing Format Selection: The second soft key permits the selection of common framing formats. The choices are D1D, D2, D3D4, and ESF.

Remote Alarm Delay Selection: The third soft key permits the delay from the receiving red alarm to the generation of remote alarm to be set at 0.3 or 2.6 seconds. Red alarm occurs for a no PCM or frame alarm. The remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the third soft key toggles the display between the two selections.

Transmit Clock Source Selection: The fourth soft key allows the operator to have the transmit clock derived from the receive clock (SLAV), or from a local clock (MSTR). The selection depends on the CTS application. If a system clock is available from the receive side, then that clock would normally be used (SLAV). If the CTS is simulating the transmission system into a channel bank then the local (MSTR) clock would be selected.

Signaling Type Selection: If D1D, D2, or D3/D4 framing format is selected, the fifth soft key selects robbed-bit (A/B), SF, or no signaling (NONE) for the PCM channel. If ESF framing format is selected, the fifth soft key selects robbed-bit (ABAB 4-state, ABCD 16-state, or AAAA 2-state), SF, or no signaling (NONE).

Idle, Drop-and-Insert, or Pattern Selection: Pressing the sixth soft key toggles the unit between idle, drop-and-insert, and pattern.

- IDLE transmits idle channel code on all channels. The selected channel receive is monitored for both traffic and signaling. This selection is used for out-of-service PCM performance testing.
- D&I (Drop & Insert) decodes the selected channel in either direction. The CTS send side is encoded onto the channel in the direction selected. The opposite direction of the channel is encoded with idle channel code. The signaling for the channel, robbed-bit or SF, is under the direct control of the operator. This mode is used for out-of-service testing of the channel. In drop-and-insert, BPVs are removed.
- PTRN (Pattern) activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or on a selected channel if channelized is selected.

Advanced Terminal PCM Setup Display 2

Figure 4-43 shows Advanced Terminal PCM Setup Display 2. This display appears if TRML and ADV are selected through PCM Setup Display 1.



Figure 4-43. Advanced Terminal PCM Setup Display 2

Zero Substitution Selection: The first soft key selects B8ZS or AMI coding.

- B8ZS (Bipolar Eight Zero Substitution) coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs (bipolar violations) for any string of 8 zeros. B8ZS coding is needed for 64-kbps clear channel operation.
- AMI (Alternate Mark Inversion) coding is a pseudo-ternary signal that conveys binary digits, where successive marks alternate between positive and negative polarity, and a space designates zero amplitude.

Framing Format Selection: The second soft key selects common framing formats. The choices are D1D, D2, D3D4, and ESF.

Remote Alarm Delay Selection: The third soft key permits the delay from the receiving red alarm to the generation of remote alarm to be set at 0.3 or 2.6 seconds. Red alarm occurs for a no PCM or frame alarm. The remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the third soft key toggles the display between the two selections. In the advanced terminal mode, the additional selection of NALM (No Alarm) inhibits remote alarm from being transmitted upon receiving red alarm.

Transmit Clock Source Selection: The fourth soft key allows the operator to have the transmit clock derived from the receive clock (SLAV), or from a local clock (MSTR). The selection depends on the CTS application. If a system clock is available from the receive side, then that clock would normally be used (SLAV). If the CTS is simulating the transmission system into a channel bank then the local (MSTR) clock would be selected.

Idle, Drop-and-Insert, and Pattern Selection: Pressing the sixth soft key toggles the unit between idle, drop-and-insert, and pattern operation. In the advanced mode, the additional selections of loopback, alarm indication signal, and remote frame alignment signal are available to the send PCM signal.

- IDLE transmits idle channel code on all channels. The selected channel receive is monitored for both traffic and signaling. This selection is used for out-of-service PCM performance testing.
- D&I (Drop & Insert) decodes the selected channel in either direction. The CTS send side is encoded onto the channel in the direction selected. The opposite direction of the channel is encoded with idle channel code. The signaling for the channel, robbed-bit or SF, is under the direct control of the operator. This mode is used for out-of-service testing of the channel. In drop-and-insert, BPVs are removed.
- LOOP (Loopback) provides a loopback of the channel undisturbed in the direction selected. It is used to "keep alive" one direction while performing an out-of-service test in the opposite direction.
- AIS (Alarm Indication Signal) causes the selected direction to be encoded with an unframed all ones pattern.
- RFALM (Remote Frame Alignment Alarm) causes the selected direction to be encoded with a remote frame alignment pattern (all bit 2s set to 0 for superframe formats and bit oriented message on facility data link for ESF).
- PTRN (Pattern) activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or on the selected channel if channelized is selected.

Direction Selection: The seventh soft key is used to select the direction (EAST or WEST) for the transmit clock source, the remote alarm delay, and the idle, drop-and-insert, and pattern selection.

Terminal PCM Setup Display 3

Pressing the SET UP key while in Terminal PCM Setup Display 2 causes Terminal PCM Setup Display 3 to appear as shown in Figure 4-44.

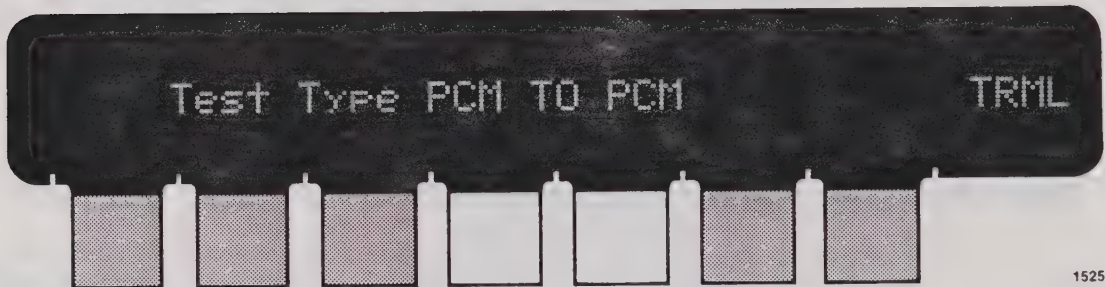


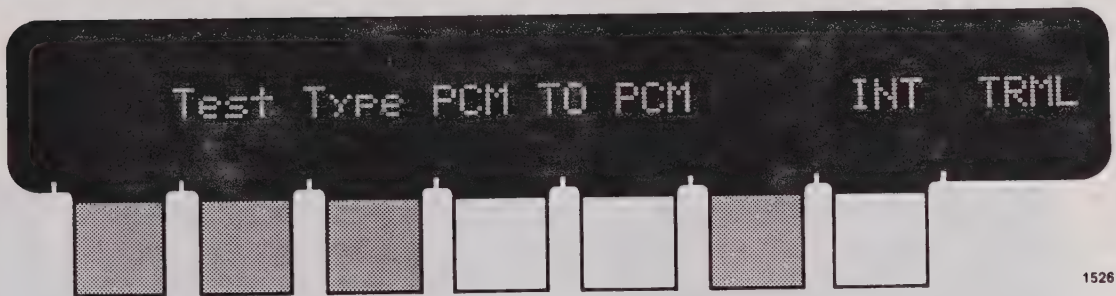
Figure 4-44. Terminal PCM Setup Display 3

The fourth and fifth soft keys toggle through the three terminal configurations.

- PCM to PCM provides for an all digital interface. This mode may be used to test the digital side of a channel bank, or to simulate a terminal device to a T1 transmission system.
- VF to PCM allows the test send side to originate from the CTS TEST LINES VF SEND jack. The receive is derived from the decoded selected channel from the selected TEST LINES PCM IN jack. This mode tests a channel bank's encoding of an analog signal.
- PCM to VF encodes the test send signal onto the selected PCM channel. The receive comes from the CTS TEST LINES VF RCV jack. This mode tests a channel bank's decoding of a digital signal.

Advanced Terminal PCM Setup Display 3

Pressing the SET UP key while in Advanced Terminal PCM Setup Display 2 causes Advanced Terminal PCM Setup Display 3 to appear as shown in Figure 4-45.



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Figure 4-45. Advanced Terminal PCM Setup Display 3

The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals. If INT (internal) is selected, the encoded signal comes from the CTS internal generator, and the decoded signal is routed through the analog measurement circuitry. If EXT (external) is selected, the encoded signal comes from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal is transmitted through the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS operates as a drop-and-insert device which may be used to connect external VF test equipment to a PCM channel.

4.8.1.3 DCS PCM Setup

By pressing the SET UP key with DCS selected, DCS PCM parameters and controls may be set up through DCS PCM Setup Display 2 or, if advanced testing is selected, Advanced DCS PCM Setup Display 2. The following paragraphs describe these displays.

DCS PCM Setup Display 2

Figure 4-46 shows DCS PCM Setup Display 2. This display appears if DCS and NORM are selected through PCM Setup Display 1.



Figure 4-46. DCS PCM Setup Display 2

Zero Substitution Selection: The first soft key selects B8ZS or AMI coding.

- B8ZS (Bipolar Eight Zero Substitution) coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs (bipolar violations) for any string of 8 zeros. B8ZS coding is needed for 64-kbps clear channel operation.
- AMI (Alternate Mark Inversion) coding is a pseudo-ternary signal that conveys binary digits, where successive marks alternate between positive and negative polarity, and a space designates zero amplitude.

NOTE: The line code selection must properly match the line code of the circuit-under-test or errors (both bit and BPVs) may be injected into the signal in the inline or DCS test arrangement.

Framing Format Selection: The second soft key selects superframe (D3D4) format or extended superframe format (ESF).

Remote Alarm Delay Selection: The third soft key permits the delay from the receiving red alarm to the generation of the remote alarm to be set at 0.3 or 2.6 seconds. Red alarm occurs for a no PCM or frame alarm. The remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the third soft key toggle the unit between the two selections.

Facility Data Link Drop-and-Insert Control: The fourth soft key selects through (fdl) or drop-and-insert (FDL) on the facility data link when extended superframe format (ESF) is selected.

NOTE: In the DCS mode, there is only one DS1 stream connected, and therefore only one facility data link connector on the rear plate is used.

Signaling Type Selection: If D3/D4 framing format is selected, the fifth soft key selects robbed-bit (A/B), SF, or no signaling (NONE) for the PCM channel. If ESF framing format is selected, the fifth soft key selects robbed-bit (ABAB 4-state, ABCD 16-state, or AAAA 2-state), SF, or no signaling (NONE).

Monitor, Drop-and-Insert, or Pattern Selection: The sixth soft key toggles the unit between monitor, drop-and-insert, and pattern.

- MON (Monitor) decodes the selected channel and its signaling in either direction for in-service PCM performance testing. Monitor does not disturb traffic or signaling on the channel. In monitor, BPVs that are received are retransmitted. In ESF, the 4-kbps facility data link may be monitored in both directions through the rear-panel 9-pin RS-232-C connectors.
- D&I (Drop & Insert) decodes the selected channel in either direction. The CTS send side is encoded onto the channel in the direction selected. The opposite direction of the channel is encoded with idle channel code. The signaling for the channel, robbed-bit or SF, is under the direct control of the operator. This mode is used for out-of-service testing of the channel. In drop-and-insert, BPVs are removed.
- PTRN (Pattern) activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or on a selected channel if channelized is selected.

Advanced DCS PCM Setup Display 3

Figure 4-47 shows Advanced DCS PCM Setup Display 3. This display appears if DCS and ADV are selected through PCM Setup Display 1.

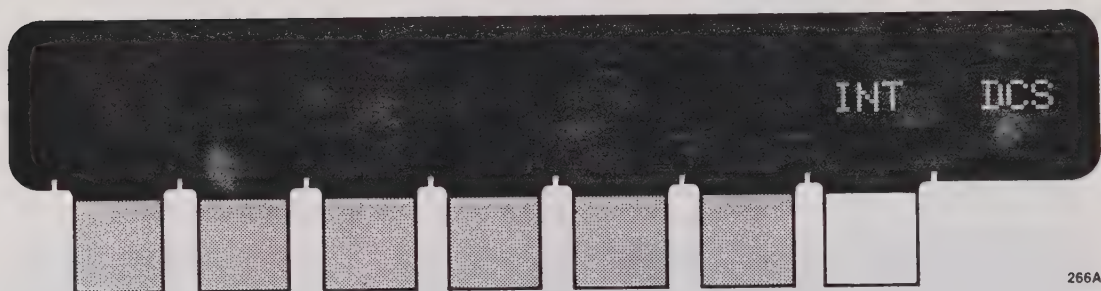


Figure 4-47. Advanced DCS PCM Setup Display 3

The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals.

- INT (Internal) allows the encoded signal to come from the CTS internal generator, and the decoded signal to be routed through the analog measurement circuitry.
- EXT (External) allows the encoded signal to come from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal to be transmitted through the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS performs as a drop-and-insert box which may be used to connect external VF test equipment to a PCM channel.

NOTE: In the EXT selection, accurate level results are obtained when the send and receive impedances are set to 600 in the line setup.

4.8.2 Inline and Terminal PCM Measurement Displays

From the inline or terminal PCM setup displays, you can access the following two inline or terminal PCM measurement displays by pressing the MEAS key:

- Inline or Terminal PCM Performance Measurement Display
- Inline or Terminal PCM Signaling and Control Measurement Display.

4.8.2.1 Inline and Terminal PCM Performance Measurement Display

The Inline and Terminal PCM Performance Measurement Display allows for in-service T1 testing. This display is shown in Figure 4-48.



Figure 4-48. PCM Performance Measurement Display (Inline or Terminal)

PCM Performance Totalizers: The left area of the display is the totalizer for the eight events and alarms which are accumulated. The count is set to zero at the start of a timed test. The maximum count is 9999. The results remain available after a test is complete until a new test starts. Pressing the third or fourth soft key rotates the display through the following events and alarms counted:

- CRC ERROR for CRC errors (*ESF only*)
- MFAS ERROR for multiframe bit errors (*superframe only*)
- ERRORED SEC for errored seconds
- REMOTE ALARM for remote frame alignment alarms
- NO PCM ALARM for no PCM alarms
- BPVs for bipolar violations
- FRAME ERROR for frame bit errors
- FRAME ALARM for frame alignment alarms
- EXCESS 0's for excessive zeros

NOTE: If Option .65 is installed, the selected from direction displays the bit error ratio measurement results. The direction not selected displays the above in-service PCM performance totalizers.

Timed Test Duration Set: The PCM performance test timer may be set for any duration from 0.1 minutes through 100 hours; with a default set to

Timed Test Duration Set: The PCM performance test timer may be set for any duration from 0.1 minutes through 100 hours; with a default set to 15 minutes. To set the timer duration, press the fifth soft key then enter the most-through-least significant digits of hours, minutes, and tenths of minutes using the keypad.

Timed Test Start/Stop: The PCM performance test timer starts and stops by pressing the sixth soft key, directly below the label T. When the label is lowercase, the timer is stopped; when the label is uppercase, the timer is running. After timing out, the label reverts to lowercase, and the accumulated results and test duration display.

Test Result Direction Selection: The performance tests are performed in both directions simultaneously. The seventh soft key allows you to display the results from the EAST or WEST.

4.8.2.2 Inline and Terminal PCM Signaling and Control Measurement Display

The Inline or Terminal PCM Signaling and Control Measurement Display, as shown in Figures 4-49 and 4-50, allows for channelized testing. This display enables you to select a channel, test direction, and either robbed-bit or SF signaling parameters.



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Figure 4-49. PCM Signaling and Control Measurement Display (Robbed-Bit Signaling)

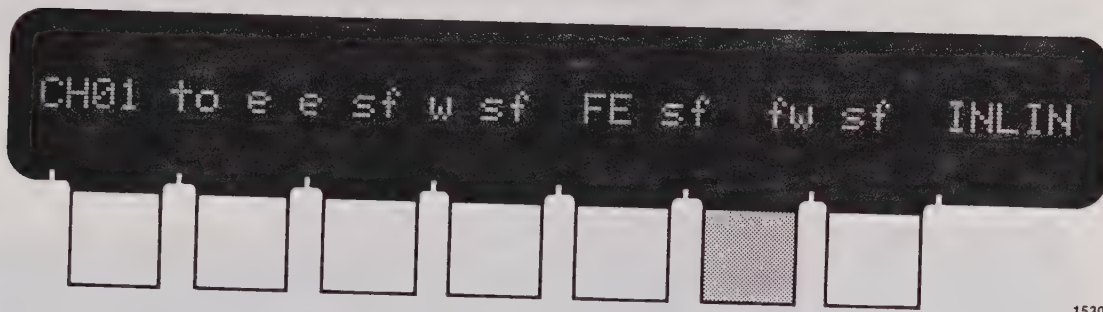


Figure 4-50. PCM Signaling and Control Measurement Display (SF Signaling)

Channel and Test Direction Selections

Channel Number Selection: The first soft key permits the entry of the desired channel number from 1 through 24. To set the channel number, press the first soft key then use the keypad to enter the two-digit channel number.

Drop-and-Insert Direction Selection: The second soft key selects the insert direction (east or west) if a drop-and-insert or pattern has been selected. Lowercase letters indicate that monitor or idle is active, while uppercase letters indicate that drop-and-insert or pattern is selected. When a test direction is selected, the receive direction is set to the same direction. In the advanced terminal mode, this soft key does not function, since independent control for each direction is provided in Advanced Terminal PCM Setup Display 2.

Robbed-Bit Signaling Selections

Manual Signaling Bit Setting: During a drop-and-insert, the signaling bits may be set in each direction by pressing the third and fourth soft keys, (see Figure 4-49). After selecting the east or west direction, use the keypad to enter a 0 or a 1 for the A bit first, then the B, C, and D bits. These bits are transmitted when the direction labels are uppercase. In monitor or idle, the signaling bits are passed through undisturbed, and the labels are lowercase.

Receive Direction Selection and Receive Robbed-Bit Display: The fifth and seventh soft keys permit the selection of the receive direction (east or west) and the display of the receive signaling bits or the receive alarm conditions.

Pressing the fifth soft key selects the receive from the east direction. Pressing the seventh soft key selects the receive from the west direction. The selected receive direction displays in uppercase (FE or FW). The signaling bits received from each direction display following the receive direction label. If a receive alarm condition exists, it replaces the receive signaling field. The receive alarm conditions are denoted by the following labels:

- NOPCM for no PCM alarm
- FALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (all ones)

SF Signaling Selections

Manual Signaling Control: During a drop-and-insert, SF supervision may be placed on the line in either or both directions using the third and fourth soft keys, (see Figure 4-50). Pressing the soft key for east sf or west sf toggles SF between uppercase and lowercase. Uppercase indicates that SF tone is transmitted. Lowercase indicates that no SF tone is transmitted. In monitor, the channel is passed through undisturbed, and the labels are lowercase.

Receive Direction Selection and Receive SF Display: The fifth and seventh soft keys permit the selection of the receive direction and the display of the receive SF status or the receive alarm conditions.

Pressing the fifth soft key selects the receive from the east direction. Pressing the seventh soft key selects the receive from the west direction. The selected receive direction displays in uppercase (FE or FW). The SF status of the direction is indicated by uppercase for tone detected and lowercase for no tone detected. If a receive alarm condition exists, it replaces the receive signaling field with one of the following labels:

- NOPCM for no PCM alarm
- FALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (all ones)

4.8.3 DCS PCM Measurement Displays

From the DCS PCM setup displays, you can access the following two DCS PCM measurement displays by pressing the MEAS key:

- DCS PCM Performance Measurement Display
- DCS PCM Signaling and Control Measurement Display.

4.8.3.1 DCS PCM Performance Measurement Display

The DCS PCM Performance Measurement Display allows for in-service T1 testing. This display is shown in Figure 4-51.

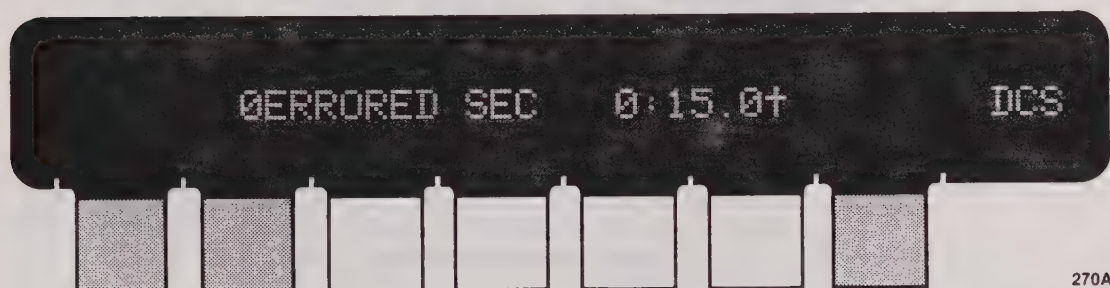


Figure 4-51. DCS PCM Performance Measurement Display

PCM Performance Totalizers: The left area of the display is the totalizer for the eight events and alarms which are accumulated. The count is set to zero at the start of a timed test. The maximum count is 9999. The results remain available after a test is complete until a new test starts. Pressing the third or fourth soft key rotate the display through the totalizers. The events and alarms counted are listed as follows:

- CRC ERROR for CRC errors (*ESF only*)
- MFAS ERROR for multiframe bit errors (*superframe only*)
- ERRORED SEC for errored seconds
- REMOTE ALARM for remote frame alignment alarms
- NO PCM ALARM for no PCM alarms
- BPV for bipolar violations
- FRAME ERROR for frame bit errors
- FRAME ALARM for frame alignment alarms
- EXCESS 0's for excessive zeros

NOTE: If Option .65 is installed, the selected from direction displays the bit error ratio measurement results. The direction not selected displays the above in-service PCM performance totalizers.

Timed Test Duration Set: The PCM performance test timer may be set for any duration from 0.1 minutes through 100 hours; with default set to 15 minutes. To set the timer duration, press the fifth soft key, then enter the most-through-least significant digits of hours, minutes, and tenths of minutes using the keypad.

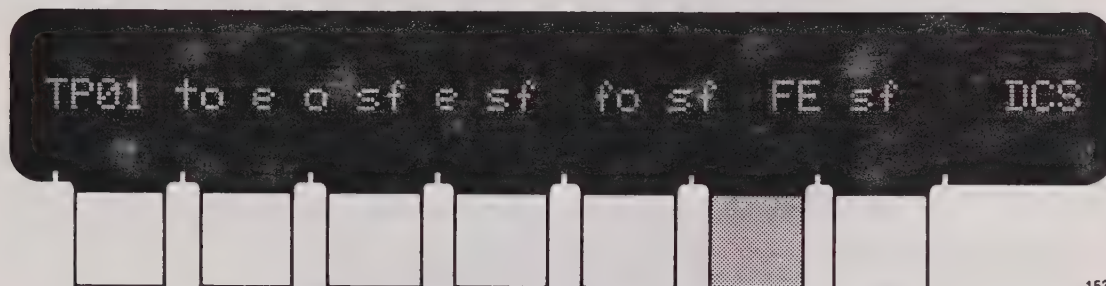
Timed Test Start/Stop: The PCM performance test timer starts and stops by pressing the sixth soft key, directly below the label T. When the label is lowercase, the timer is stopped; when the label is uppercase, the timer is running. After timing out, the label reverts to lowercase, and the accumulated results and test duration display.

4.8.3.2 DCS PCM Signaling and Control Measurement Displays

The DCS PCM Signaling and Control Measurement Display, shown in Figures 4-52 and 4-53, allows for channelized testing. This display allows you to select a channel, test direction, and either robbed-bit or SF signaling parameters.



Figure 4-52. DCS PCM Signaling and Control Display (Robbed-Bit Signaling)



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Figure 4-53. DCS PCM Signaling and Control Display (SF Signaling)

Port and Test Direction Selections

Test Port Number Selection: The first soft key permits the entry of the desired DCS test port from 1 through 12. To set the DCS test port number, press the first soft key then use the keypad to enter the test port's two-digit number. This is the first of the pair of adjacent channels on which monitor, drop-and-insert, or pattern are performed.

Drop-and-Insert Direction Selection: The second soft key selects the insert direction (odd or even) if drop-and-insert, or pattern has been selected. Lowercase letters indicate that monitor is active, while uppercase letters indicate that drop-and-insert or pattern is selected. When the test direction is selected, the receive direction is set to the same direction.

Robbed-Bit Signaling Selections

Manual Signaling Bit Setting: During drop-and-insert, the signaling bits may be set in each direction by pressing the third and fourth soft keys, (see Figure 4-52). After selecting the odd or even direction, use the keypad to enter a 0 or 1 starting with the A bit first. These bits are transmitted when the direction labels are uppercase. In monitor, the signaling bits are passed through undisturbed, and the labels are lowercase.

Receive Direction Selection and Robbed-Bit Display: The fifth and seventh soft keys permit the selection of the receive direction (odd or even), and the display of the receive signaling bits or the receive alarms. Pressing the fifth soft key selects the receive from the odd channel. Pressing the seventh soft key selects the receive from the even channel. The selected receive direction displays in uppercase (FO or FE). The signaling bits received from each channel display following the receive direction label. If a receive alarm condition exists, it replaces the receive signaling field. The receive alarm conditions are denoted by the following labels:

- NOPCM for no PCM alarm
- FALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (all ones).

SF Signaling Selections

Manual Signaling Control: During a drop-and-insert, SF supervision may be placed on the line of either or both channels using the third and fourth soft keys (see Figure 4-53). Pressing the soft key for odd or even, labeled O or E, toggles SF between uppercase and lowercase. Uppercase indicates that SF tone is transmitted, while lowercase indicates that no SF tone is transmitted. In monitor, the channel is passed through undisturbed, and the labels are lowercase.

Receive Direction Selection and Receive SF Display: The fifth and seventh soft keys permit the selection of the receive direction and the display of the receive SF status, or the receive alarm conditions.

Pressing the fifth soft key selects the receive from the odd channel. Pressing the seventh soft key selects the receive from the even channel. The selected receive direction displays with its label in uppercase (FO or FE). The SF status of the channel is indicated by uppercase for tone detected and lowercase for no tone detected. If a receive alarm condition exists, it replaces the receive signaling field with one of the following labels:

- NOPCM for no PCM alarm
- FALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (all ones).

4.9 Optional Tests

This section contains instructions for performing measurements that are optional for 3700-series CTSs. To perform these measurements, the CTS must be equipped with the required option board.

NOTE: Some options are now included as standard equipment in all CTSs.

This section covers the following optional measurements:

- Transients which requires Option .11, Three-Level Impulse Noise, and part of Option .13 Hits/Jitter
- Envelope Delay which requires Option .12 or .12A Envelope Delay
- Jitter which requires part of Option .13 Hits/Jitter
- Intermodulation Distortion which requires Option .14 Intermodulation Distortion or part of Option .30
- P/AR which requires Option .18, .18A, or part of Option.30
- VOM/CAP which requires Option .40 VOMCAP
- Responder Interface which requires Option .52 Responder Interface
- T1 Bit Error Ratio which requires Option .65 T1 Bit Error Ratio.

4.9.1 Transients (Option .11 and p/o .13)

This section describes the operating procedures for the transient measurements of three level impulse noise (Option .11), and gain hits, phase hits, and dropouts (part of Option .13).

Transients tests are the accumulation of transient events on the transmission circuit over a specified timed duration. These tests are designed to measure the occurrence of events which are likely to cause bit errors during data transmission by modems on a VF circuit. The options are designed to meet the specifications in Bell System Technical Reference PUB 41009.

The three-level impulse noise option measures and displays the number of times impulse noise (defined as any excursion of a band-limited signal above a preset threshold) occurs within a specified time period. The option is calibrated in dBm to respond to the peak value of the received signal. Three thresholds are provided. The low threshold is set through the ENTER keypad in 1-dB steps from 30 through 106 dBm; 40 through 106 dBm for Option .10, and 15-kHz flat, program, 50 kilobit, or 50-kHz flat filters. High thresholds are determined by a spread, which is set through the keypad either to 2, 4, 6, or 8 dB.

The receive signal can be weighted by a C-message filter or, with options, a 15-kHz flat, program, 50 kilobit, or 50-kHz flat filter. A 1010-Hz test tone notch filter can also be selected.

The hit and dropout measurements are performed on a channel with a 1-kHz holding tone. The measurement results are the timed total counts of phase hits, gain hits, and dropouts. The peak phase hit threshold is set through the keypad in 5-degree steps from 5 degrees through 50 degrees; the gain hit threshold is set in 1-dB steps from 1 dB through 10 dB; and the dropout threshold is 12 dB below the level of the receive holding tone. Phase and gain hits and dropouts must last for at least 4 milliseconds to qualify as valid counts. A standard count rate (7 per second) and a fast count rate (100 per second) are provided for hits.

The measurement timer may be set from 1 through 60 minutes or continuous for longer tests. The receive level and frequency may be monitored during the test by pressing the LEVEL key. The impulse noise display returns by pressing the IMPLS NOISE key. The impulse noise measurement may be made concurrently with hit and dropout measurements when Option .13 is installed. Impulse noise counts are optionally interlocked with hits and dropouts to prevent extraneous counts.

During impulse noise measurements, the monitor signal is taken from the impulse noise threshold point that has been weighted by the noise filter and test tone notch, if selected. During hit measurements, the monitor signal is taken directly from the receive signal. The MONITOR VOL control may be used to adjust volume for input level variations.

Specifications for Options .11 and .13 are provided in the equipment descriptions section.

4.9.1.1 Transients Setup Display

To set up a transients measurement, press the TRANSIENTS key in the MEASUREMENT section of the front panel. The Transients Setup Display appears as shown in Figure 4-54.

Transients Test Selection: If Option .13 Hits/Jitter is installed, the first two soft keys may be used to select measurement of impulse noise and/or hits. Uppercase letters indicate that a measurement is active.

Count Rate Selection: To select the Bell System standard count rate of 7 counts per second, press the soft key below std. To select the fast count rate of 100 counts per second, press the soft key below fast.



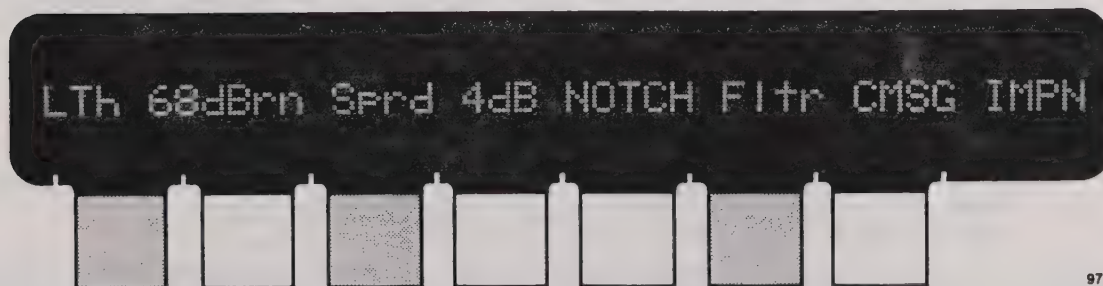
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Figure 4-54. Transients Setup Display

Timer Interval Entry: To set the measurement timer interval in minutes, press the soft key below Min. Numeric digits become underline characters. Enter an interval of 1 through 60 minutes, starting with the most to least significant digit. For continuous timer operation, enter any interval greater than 60 (i.e., 61 through 99); CONT appears where xxMin was located.

4.9.1.2 Impulse Noise Setup Display

To set up the impulse noise measurement, press the SET UP key in the DISPLAY section of the front panel until the Three-Level Impulse Noise Setup Display appears as shown in Figure 4-55.



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Figure 4-55. Three-Level Impulse Noise Setup Display

Low Threshold Entry: To set the low threshold, press the second soft key. All digits become underlines. Enter a new threshold in the range of 30 through 106 dBm, starting with the most significant digit; 40 through 106 dBm for Option .10, and 15-kHz flat, program, 50 kilobit, or 50-kHz flat filters.

Threshold Spread Entry: To set the low-to-mid and mid-to-high threshold spread, press the fourth soft key. Enter the new spread of 2, 4, 6, or 8 dB.

Weighting Filter Selection: A 1010-Hz notch filter and the following weighting filters can be selected:

- C-Message
- 15-kHz flat (requires Option .15, .15B, or .15C)
- Program (requires Option .15)
- 50 kilobit (requires Option .15B or .15C)
- 50-kHz flat (requires Option .10 and .15C)

As indicated, some filter selections are available only if either an Option .15, .15B, or .15C Noise Filter is installed in the CTS.

NOTE: Only one noise filter option may be installed in the CTS.

To select the weighting filter, press the seventh soft key until the desired characters display. The filters that correspond to the filter selection are as follows:

- CMSG for C-Message
- 15FLAT for 15-kHz flat
- PRGM for program
- 50KB for 50 kilobit
- 50FLAT for 50-kHz flat

1010-Hz Notch Filter Selection: To select the 1010-Hz notch filter, press the fifth soft key.

4.9.1.3 Impulse Noise Measurement Display

To perform an impulse noise measurement, press the MEAS key in the DISPLAY section of the front panel. The Impulse Noise Measurement Display appears as shown in Figure 4-56.

Impulse Noise Totalizers: Three 4-digit count totalizers appear at the left of the display. The totals continue to display until reset to zero at the start of a new timed test.



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Figure 4-56. Impulse Noise Measurement Display

Tone Loss Indicator: The flag message, NO TONE, showing that the test tone has been interrupted, appears on the display if dropouts are not being counted. The test tone is 995 through 1025 Hz at +10 through -40 dBm. Once the test tone is interrupted, the flag remains displayed until a new test is started. If hits and dropouts are also being counted, the tone loss indicator appears when the test tone drops out and disappears when the test tone returns.

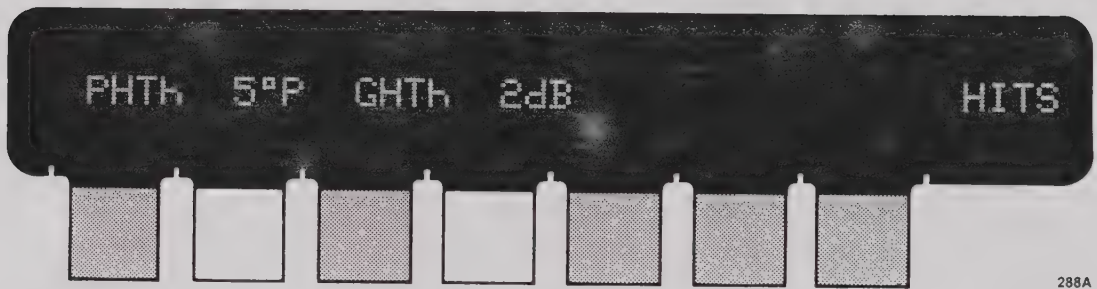
Measurement Timer Controls: To start a timed test of impulse noise, or impulse noise, hits, and dropouts, press the seventh soft key. The test starts on the transition of min to uppercase letters. To stop a test, press the soft key again: MIN changes to lowercase letters and the measurement stops. When the test ends, a long burst of the key tone sounds on the monitor to alert the user. The current test results continue to display until a new test starts .

4.9.1.4 Hits Setup Display

To set up the hits measurement, press the SET UP key in the DISPLAY section of the front panel until the Hits Setup Display appears as shown in Figure 4-57.

Phase Hit Threshold Entry: To set the peak phase hit threshold, press the soft key below P. Enter the new threshold in 5-degree steps, from 5 degrees through 50 degrees, starting with the most significant digit.

Gain Hit Threshold Entry: To set the gain hit threshold, press the fourth soft key. Enter the new threshold in 1-dB steps, from 1 dB through 10 dB.

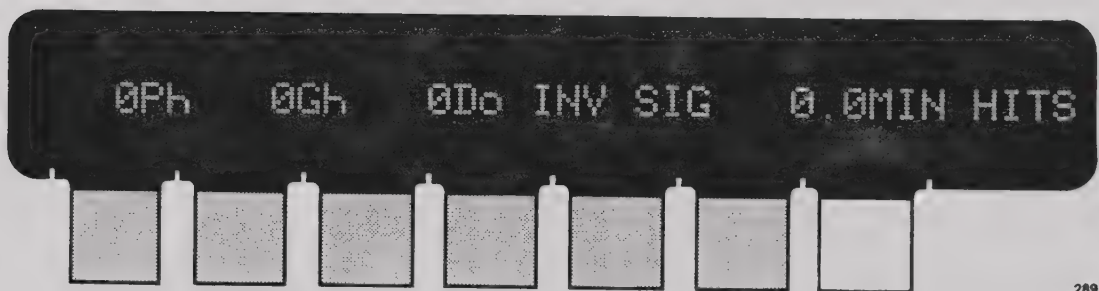


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Figure 4-57. Hits Setup Display

4.9.1.5 Hits Measurement Display

To perform a hits measurement, press the MEAS key in the DISPLAY section of the front panel. The Hits Measurement Display appears as shown in Figure 4-58.



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Figure 4-58. Hits Measurement Display

Hit and Dropout Totalizers: Three 4-digit count totalizers for phase hits, gain hits, and dropouts appear on the left side of the display. The totals continues to display until reset to zero at the start of a new timed test.

Caution Flag: At the start of a hits and dropouts test, if the receive test tone is outside the range of 995 through 1025 Hz or +10 through -40 dBm, the caution flag INV SIG appears following the totalizers. The flag remains latched until the start of a new test.

Measurement Timer Control: To initiate a timed test of hits and dropouts or impulse noise, hits, and dropouts, press the soft seventh key. The test starts on the transition of min to uppercase letters. To stop a test, press the soft key again; MIN changes to lowercase and the measurement stops. When the test completes, a long burst of the key tone sounds on the monitor speaker to alert the user. The current test results continue to display until a new test starts.

4.9.2 Envelope Delay (Option .12 or .12A)

This section describes the operating procedures for envelope delay measurements using Option .12 or .12A. Specifications for Options .12 and .12A are provided in the equipment descriptions section.

NOTE: Option .12A is for use in units with Firmware Revision 12 or later. Option .12 may work in all units, but may require factory rework to function in units with Firmware Revision 12 or later.

This option measures and displays envelope delay distortion. Designed to meet Bell System and IEEE standards, all measurement modes utilize 83 1/3-Hz modulation and are compatible with WECO and other commercial sets with similar features. By using a unit at either end of the circuit, the master and slave modes can provide forward and return reference delay measurements. Direct loop measurements of delay can be made with a single unit. During delay measurements, the monitor signal is taken directly from the receive side.

4.9.2.1 Forward Reference Delay Measurement

Figure 4-59 shows the configuration of a forward reference delay measurement. The master station sends a reference carrier frequency plus modulation. The slave station recovers the modulation and uses it to modulate its send carrier to the slave station. The slave station send carrier is swept to obtain the amplitude and delay distortion information at the master station for the slave-to-master circuit.

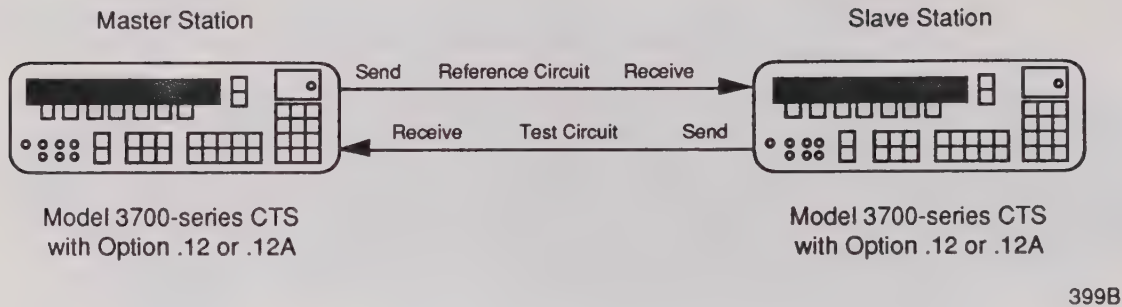


Figure 4-59. Forward Reference Delay Measurement

4.9.2.2 Return Reference Delay Measurement

Figure 4-60 shows the configuration of a return reference delay measurement. The master modulates its send carrier with its internal modulation generator; the slave station recovers the modulation and modulates the reference carrier frequency on its send side. The master station send side is swept to obtain the delay distortion information at the slave station for the master-to-slave circuit. Amplitude information may also be obtained if the amplitude repeat mode is selected at the slave station. The slave varies its send level to follow its receive level.

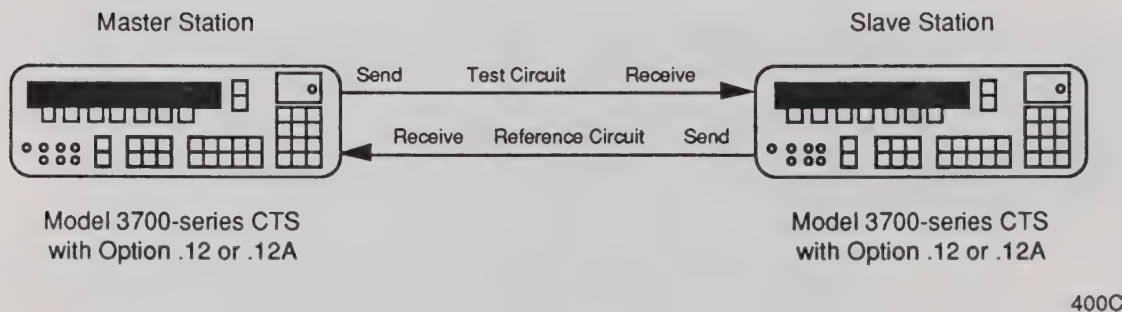
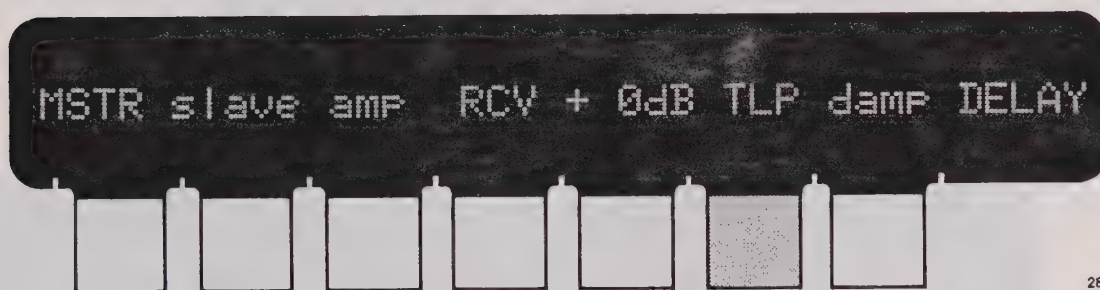


Figure 4-60. Return Reference Delay Measurement

4.9.2.3 Envelope Delay Setup Display

To perform an envelope delay measurement, press the DELAY key in the MEASUREMENT section of the front panel. The Envelope Delay Setup Display appears as shown in Figure 4-61.



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Figure 4-61. Envelope Delay Setup Display

Master/Slave Mode Selection: If the unit is to collect the envelope delay distortion data, press the soft key below mstr. If the unit is to aid in the collection of the delay distortion data at the distant end, press the soft key below slave.

Amplitude Repeat Selection: When SLAVE is selected and a return reference measurement is being made, pressing the soft key below amp permits amplitude distortion data as well as delay distortion data to be displayed at the master station. Uppercase letters indicate that amplitude repeat is active.

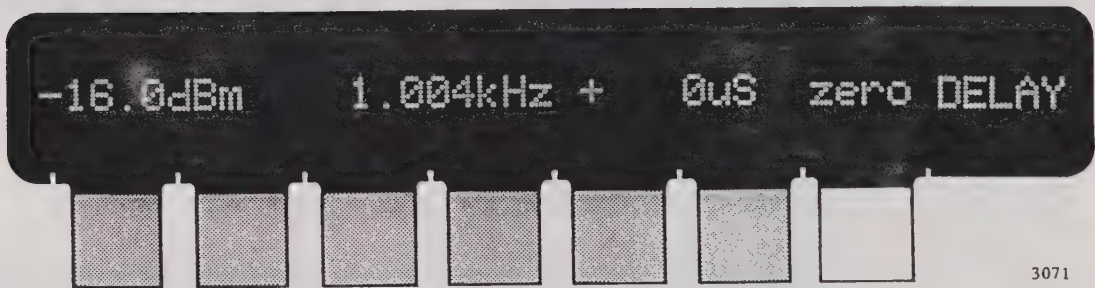
Receive/Send Frequency Selection: Either the receive or send frequency may be selected in the set up display. Pressing the soft key below RCV or SEND toggles the display from one selection to the other. For return reference measurements, the master station should select SEND so that the measurement frequency displays, and the slave station should select RCV. For forward reference measurements, the master station should select RCV, and the slave station should select SEND.

TLP Entry: To enter a TLP for the level measurement, press the fifth soft key. Enter a "+" or "-" sign, then the most-through-least significant digits.

Damping: The CTS Option .17 displays envelope delay as a running average of four readings, with an update rate of 4.167 Hz. If the soft key below damp is pressed, DAMP appears in all uppercase letters and subsequent readings will be a running average of 16 readings. To toggle the feature off, press the soft key again.

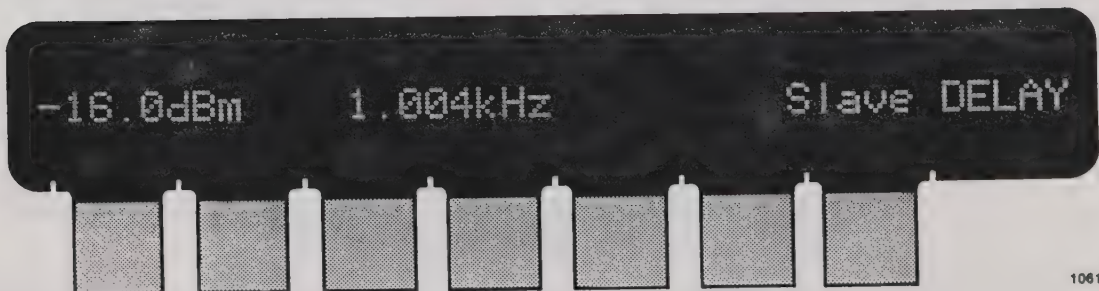
4.9.2.4 Envelope Delay Measurement Display

The Envelope Delay Measurement Display is selected by pressing the MEAS key, located directly above the SET UP key. See Figure 4-62 for the master mode and Figure 4-63 for the slave mode.



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Figure 4-62. Envelope Delay Measurement Display (Master Mode)



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Figure 4-63. Envelope Delay Measurement Display (Slave Mode)

Receive Level Measurement Display: The level measurement range is +10.0 through -70.0 dBm for absolute level measurement. The units of measurement are as follows:

- dBm for absolute level measurements
- dBm0 for level measurements relative to a TLP
- dB for level measurements relative to a reference level.

Frequency Display: The frequency display follows the level measurement and appears in kHz with a resolution of 1 Hz. The frequency display is the receive or send frequency as selected in the Envelope Delay Setup Display. If the receive level is below -51.9 dBm, the digits of the frequency display are replaced by an asterisk *.

Delay Measurement and Flags: The envelope delay displays in microseconds with a range of -3000 through +9000 microseconds. If the receive signal is without 83 1/3-Hz modulation, the delay reading is replaced by INV SIG. If the receive signal is <-40 dBm or >+10 dBm, the delay reading is replaced by INV LEVEL.

Zero Reference Set: When functioning in the master mode, the soft key below zero allows setting the delay reading to zero at the reference frequency.

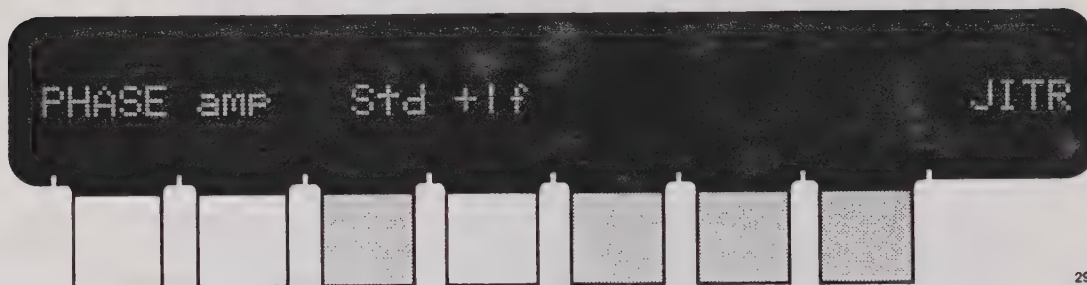
4.9.3 Jitter (p/o Option .13)

This section describes the operating procedures for jitter measurements using Option .13. This option provides measurements of phase hits, gain hits, dropouts, and phase and amplitude jitter. Specifications for Option .13 are provided in the equipment descriptions section.

Phase and amplitude jitter measurements are made on a 990 through 1030 Hz holding tone within a level range of +10 through -40 dBm. Phase and amplitude jitter may be measured with the standard weighting of 20 through 300 Hz, or an extended low frequency weighting of 4 through 20 Hz. The jitter measurements are made in the range of 0.0 through 30.0 degrees peak-to-peak for phase jitter and 0.0 through 30.0 percent peak for amplitude jitter. Overrange is indicated by all digits being replaced by +. A self-test send signal is provided to check the function of the phase and amplitude jitter measurements.

4.9.3.1 Jitter Setup Display

To set up a jitter measurement, press the JITTER key in the MEASUREMENT section of the front panel. The Phase/Amplitude Jitter Setup Display appears as shown in Figure 4-64.



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Figure 4-64. Phase/Amplitude Jitter Setup Display

Phase/Amplitude Jitter Selection: To select phase jitter measurements, press the soft key below phase. To select amplitude jitter measurements, press the soft key below amp.

Jitter Frequency Weighting Selection: To select the extended low frequency weighting of 4 through 20 Hz, press the soft key below lf. The extended range is selected when LF is all uppercase letters. To return to the standard 20 through 300 Hz range, press the soft key again.

4.9.3.2 Jitter Measurement Displays

To perform a jitter measurement, press the MEAS key. Depending on the phase/amplitude jitter setup, Figure 4-65 or 4-66 appears.

NOTE: The monitor obtains its signal directly from the receive side when JITR displays.

Receive Level and Frequency Measurement: The left of the display shows the receive level and frequency in dBm and kHz. For valid jitter measurements, the receive tone must be between +10 through -40 dBm and 990 through 1030 Hz.

Phase/Amplitude Jitter Measurement: Following the receive level and frequency is the phase or amplitude jitter measurement. Phase jitter displays from 0.0 through 30.0 degrees peak-to-peak and amplitude jitter from 0.0 through 30.0 percent peak.

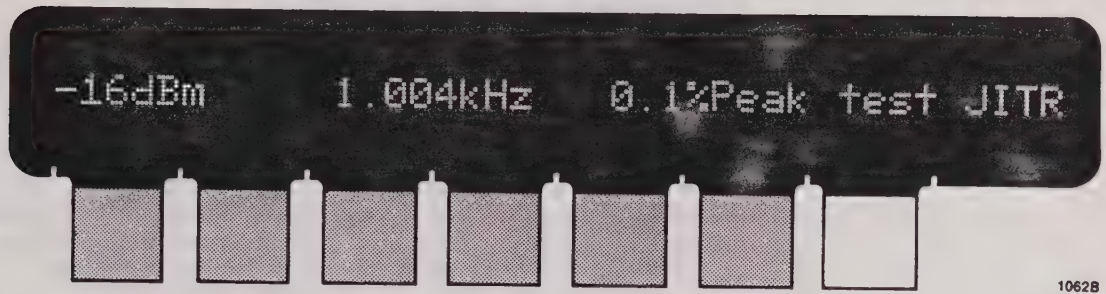


Figure 4-65. Phase Jitter Measurement Display

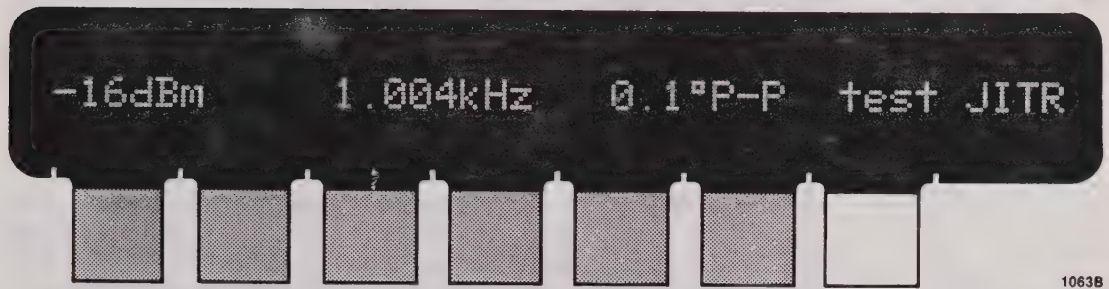


Figure 4-66. Amplitude Jitter Measurement Display

Caution Flags: If the level is outside the range of +10 through -40 dBm, INV LEVEL replaces the jitter data. If the level is correct and the frequency is outside the range of 990 through 1030 Hz, INV SIG replaces the jitter data.

NOTE: The receive level is measured through a weighted filter centered around 1010 Hz.

Self-Test: To activate the self-test send signal, press the soft key below test. This causes the generator to send a signal with 21.4 ± 1.3 degrees peak-to-peak and $18.6 \pm 1.1\%$ peak.

NOTE: The send and receive sides must be looped back either at the jacks, or through a remotely controlled internal loopback to perform a self-test.

4.9.4 Intermodulation Distortion (Option .14 and p/o .30)

This section describes the operating procedures for intermodulation distortion measurements (Option .14 and part of Option .30). This option measures and displays second and third order intermodulation distortion products. The option is designed to meet Bell System Technical Reference PUB 41009, IEEE Standard 743-1984, and CCITT Recommendation O.42.

Channel intermodulation distortion is measured using a 4-tone technique (Hekimian Patent No. 3,862,380). Tone pairs centered at 860 and 1380 Hz are applied to the channel at the distant end. The combination of inband second and third order intermodulation distortion products are then measured and displayed.

The display shows caution flags which are activated by the receive signal. If the receive signal is below -40 dBm or above 0 dBm, INV LEVEL displays. If the receive signal is not a 4-tone test signal, SPURIOUS displays. If the receive signal contains just one tone pair, RCV S/N displays. The S/N (signal-to-noise) check signal is used to verify that the product readings are not due to noise, but are the actual distortion products. This is accomplished by removing the lower tone pair and increasing the remaining tone pair by 3 dB. On the receive end, the distortion readings are then compared to those with the 4-tone signal. Table 4-3 shows the correction factor required to compensate for the effects of channel noise on the intermodulation distortion measurement. This must be done for both second and third order product readings. When IMD displays, the monitor obtains its signal directly from the receive side.

Table 4-3. Intermodulation Distortion Measurement Correction Factors

If the S/N reading test is more than the intermodulation distortion reading by one of the values indicated below...		... add the corresponding correction factor to the intermodulation distortion reading.
11 dB or greater		0
10		0.5
9		0.6
8		0.7
7		1.0
6		1.3
5		1.7
4		2.2
3		3.0
2		4.3
1		6.9
0		(Distortion reading is entirely due to noise)

4.9.4.1 Intermodulation Distortion Setup Display

There is no setup display for intermodulation distortion. To perform an intermodulation distortion measurement, press the IMD key in the MEASUREMENT section of the front panel.

4.9.4.2 Intermodulation Distortion Measurement Display

Receive Level Measurement: On the left side of the display, shown in Figure 4-67, is the receive level measurement result in dBm rms (root-mean-square). The receive level of the test signal must be in the range of 0 through -40 dBm for accurate measurements.

Distortion Product Measurements: The second and third order distortion products are displayed in dB below the receive test signal. The readings are in the range of +10 through +70 dB. When INV LEVEL and SPURIOUS display, the product digits are replaced by two asterisks (**)



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Figure 4-67. Intermodulation Distortion Measurement Display

Caution Flags: The following caution flags display in place of the distortion product readings, or in an area following the distortion product readings when certain receive conditions occur:

- INV LEVEL where a level out of the range of 0 through -40 dBm is received
- SPURIOUS where the receive signal does not meet 4- or 2-tone S/N test signal requirements
- RCV where a tone pair drops for a receive S/N check.

S/N Check Activation: To activate the S/N check test signal on the send side, press the soft key below snt on the display. The S/N check verifies that distortion products are being measured and not noise, and allows correction of the results for the effects of noise.

Self Test: To activate the self-test send signal, press the soft key below test. This causes the generator to send a signal containing 35 dB of second and third order products.

NOTE: The send and receive sides must be looped back either at the jacks, or through a remotely controlled internal loopback to perform a self-test.

4.9.5 P/AR (Option .18, .18A, and p/o .30)

This section describes the operating procedures for P/AR (peak-to-average ratio) measurements, (Option .18, .18A, and part of .30). Option .18A and .30 may be used only in units with Revision 12 or greater firmware. Option .18 may be used in all units.

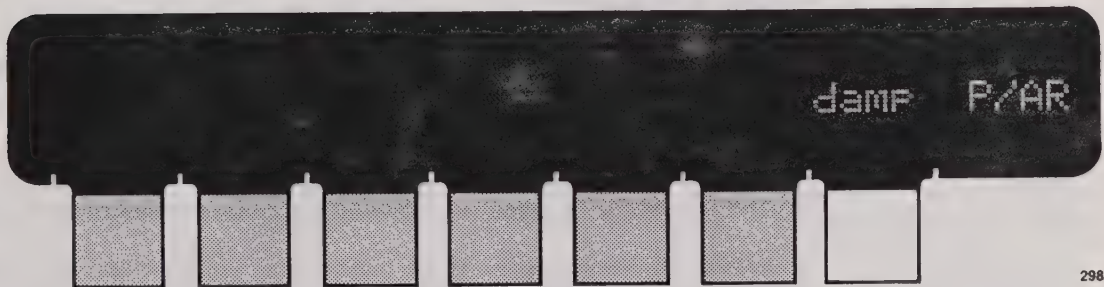
This option is designed to perform P/AR measurements in accordance with Bell System Technical Reference PUB 41009 and IEEE Standard 743-1984. The option includes a generator which produces the specified spectrum of 16 frequency components. The P/AR measurement is designed to show the effects of envelope delay distortion, amplitude distortion, and poor return loss on voiceband data signals.

The receive side of the P/AR weights the receive signal, and then measures the absolute peak value and the average value of the receive spectrum. Their ratio is displayed on a zero-suppressed scale. A P/AR signal experiencing no distortion displays 100 P/AR units. Actual measurement results are displayed in the range of 0 through 120 P/AR units.

A DAMP soft key is provided to reduce reading fluctuations if desired. This is accomplished by displaying a running average of eight P/AR readings. The monitor obtains its signal directly from the receive side when P/AR is active.

4.9.5.1 P/AR Setup Display

To set up a P/AR measurement, press the P/AR key in the MEASUREMENT section of the front panel. The P/AR Setup Display appears as shown in Figure 4-68.



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Figure 4-68. P/AR Setup Display

To reduce fluctuations in the P/AR measurement readings, a running average of eight samples may be selected by pressing the seventh soft key below damp. When DAMP is all uppercase letters, it is active; pressing the soft key again toggles it off. This damping does not change the level reading response.

4.9.5.2 P/AR Measurement Display

To perform a P/AR measurement, press the MEAS key in the DISPLAY section of the front panel. The P/AR Measurement Display appears as shown in Figure 4-69.

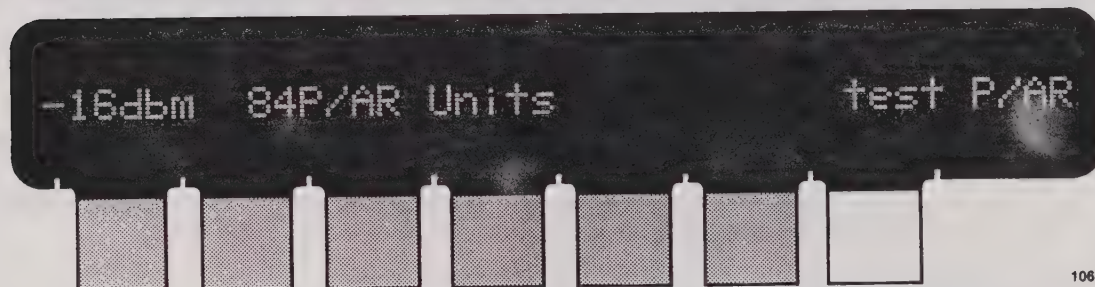


Figure 4-69. P/AR Measurement Display

Receive Level Measurement: The left of the display shows the receive level in dBm rms. The P/AR measurement has a valid receive level range of 0 through -40 dBm.

P/AR Measurement: P/AR is measured in P/AR units, from 0 through 120. Underrange is indicated by replacing the digits with "-" signs, and overrange is indicated by "+" signs.

Invalid Level Flag: If the receive level is below -40 dBm or above 0 dBm, INV LEVEL displays following the P/AR measurement display.

Self-Test: To activate the self-test send signal, press the soft key below test. This causes the generator to send a modified P/AR signal which should read 59 P/AR units.

NOTE: The send and receive sides must be looped back either at the jacks, or through a remotely controlled internal loopback to perform a self-test.

4.9.6 VOM/CAP (Option .40)

This section describes the operating procedures for the VOM/CAP measurements: ac and dc voltage and current, resistance, and capacitance.

In general, a telephone line has the combined characteristics of resistance, capacitance, and inductance. These characteristics interact so that resistance has an effect upon capacitance measurements, and capacitance has an effect upon resistance measurements. Option .40 uses a sampled data system measurement technique that offers a compromise in minimizing the effect of this interaction on measurement accuracy. In addition, this sampled data system technique greatly reduces the effects of foreign voltage and background interference on resistance and capacitance measurements.

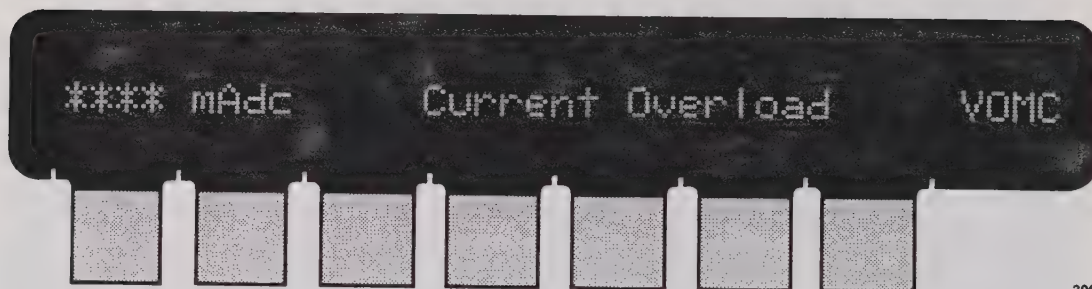
Access to the Option .40 is through the NORM-SEND (2W) jack or corresponding rear-panel terminals. Measurements may be made tip-to-ring, tip-to-sleeve, or ring-to-sleeve. The line reversal function allows transfer of the connections to the NORM-RCV jack or corresponding rear-panel terminals.

CAUTION: Although the Option .40 is designed to accurately measure high ac and dc voltages (± 200 Vdc and 160 Vac), these voltage levels cannot be tolerated in any other measurement mode of the CTS. Therefore, always activate the VOM/CAP option before connecting the line to be measured. Disconnect the line before entering any other measurement mode.

When making measurements using Option .40, the measurement sequence should always start with voltage and current measurements, then proceed with resistance or capacitance measurements. If voltage or current measurements indicate overrange or overload, resistance and capacitance measurements should not be attempted. These measurements may not be meaningful and can result in a blown fuse on the Option .40 printed circuit board.

When the Option .40 initiates a capacitance measurement, it first places a momentary short across the line to discharge any capacitance present and minimize the effects of foreign voltage. For this reason, Vdc, Vac, mAdc and mAac measurements should always be made prior to making a capacitance measurement.

In voltage and current measurements, overrange in a positive direction is indicated by four plus signs (++++), and overrange in a negative direction is indicated by four minus signs (----). In resistance and capacitance measurements, if a valid reading cannot be made, four asterisks (****) replace the digits. In current measurements, an overload is indicated by four asterisks and a current overload message. The current overload message is shown in Figure 4-70.



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Figure 4-70. Current Overload Display

Specifications for Option .40 VOM/CAP measurements are contained in the equipment descriptions section.

4.9.6.1 VOM/CAP Setup Display

To set up a VOM/CAP measurement, press the VOMC key in the MEASUREMENT section of the front panel. The VOM/CAP Setup Display appears as shown in Figure 4-71. Press the soft key below the desired measurement mode; vdc, vac, madc, maac, res, or cap. The default measurement is dc voltage.



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Figure 4-71. VOM/CAP Setup Display

4.9.6.2 Voltage and Current Measurement Display

Press the MEAS key in the DISPLAY section of the front panel. With any of the first four soft keys selected in the VOM/CAP Setup Display, voltage or current measurement displays, appear as shown in Figures 4-72 through 4-75.

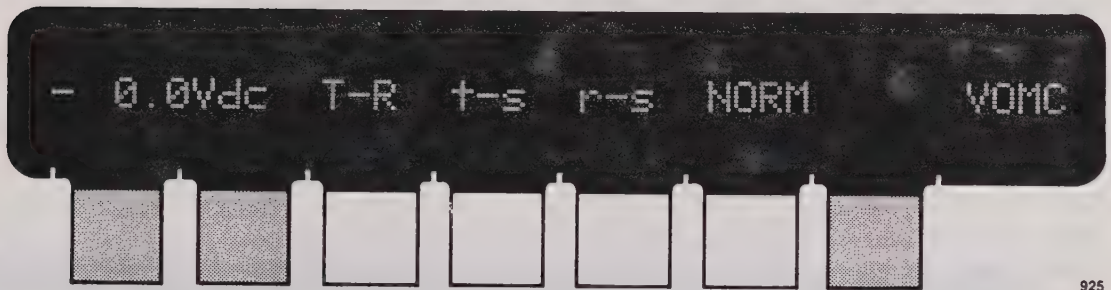


Figure 4-72. Volts DC Measurement Display

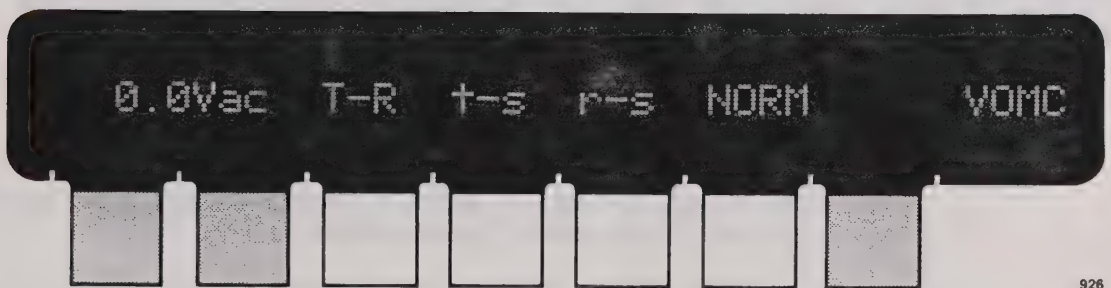
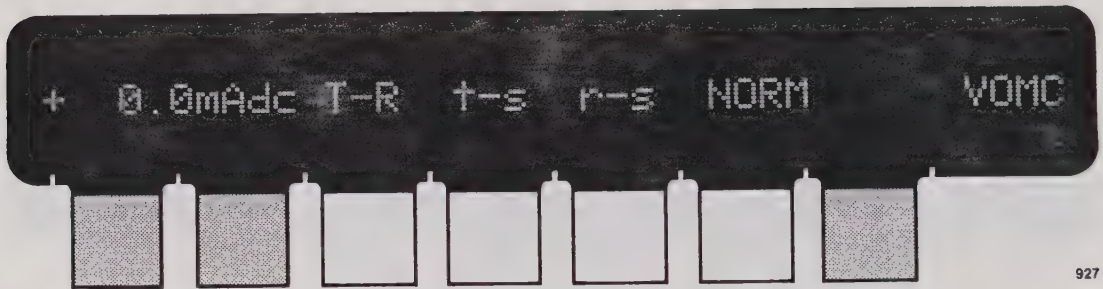
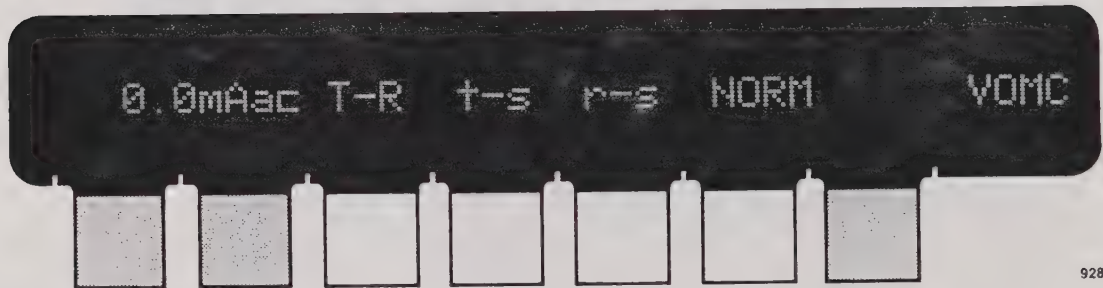


Figure 4-73. Volts AC Measurement Display



927

Figure 4-74. Milliamperes DC Measurement Display



928

Figure 4-75. Milliamperes AC Measurement Display

Press the soft key below the desired input configuration; tip-to-ring, tip-to-sleeve, or ring-to-sleeve. The default setting is T-R.

CAUTION: During operation, a 100 Vdc source is applied periodically through approximately 100 kilohms to the line under test. A high residual voltage may be left on a capacitance being measured.

With NORM selected, connect the line under test to the NORM SEND (2W) jack in the TEST LINE section of the front panel. With REV selected, connect the line under test to the NORM RCV jack. The measurement results display to three significant digits.

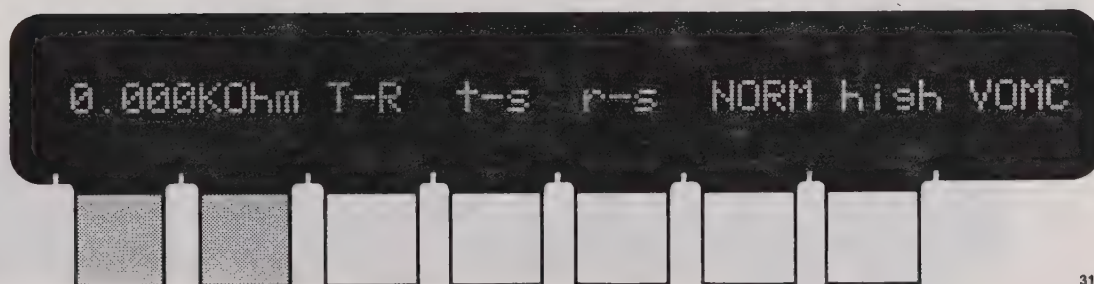
To change measurement mode, return to the setup display by pressing the SET UP key in the DISPLAY section of the front panel.

4.9.6.3 Resistance Measurement Display

Resistance measurements are made using a sampled data technique. Option .40 measures a change in voltage and the corresponding change in current, and calculates the resistance value. This technique reduces the effect of foreign voltage on the measurement.

There are two measurement ranges, a normal range and high range, used with resistance measurements. The high range extends the upper limit from 2.0 megohms to 20.0 megohms. The high range also increases the time measurement by a factor of four. It is, therefore, more susceptible to changes in foreign voltage. This high range is useful for leakage tests, but it is recommended that the normal range be used for values below 2.0 megohms.

With RES selected in the VOM/CAP Setup Display, press the MEAS key in the DISPLAY section of the front panel. The Resistance Measurement Display appears as shown in Figure 4-76. Press the soft key below the desired input configuration; tip-to-ring, tip-to-sleeve, or ring-to-sleeve. The default setting is T-R.



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Figure 4-76. Resistance Measurement Display

With NORM selected, connect the line under test to the NORM SEND (2W) jack in the TEST LINE section of the front panel. With REV selected, connect the line under test to the NORM RCV jack.

Press the seventh soft key to select the desired range. The measurement results display to three significant digits.

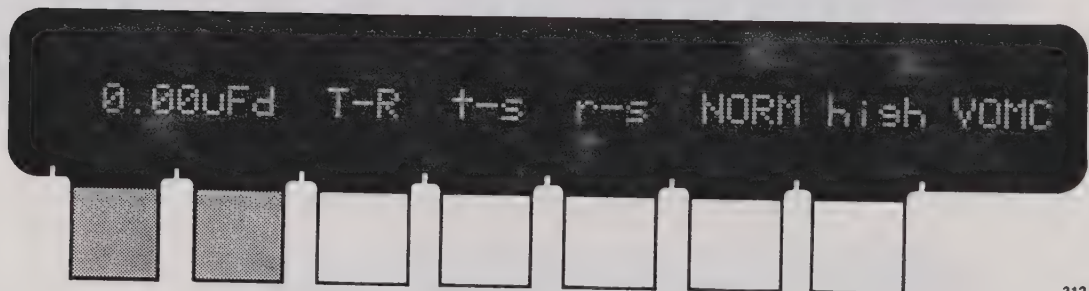
To change measurement mode, return to the setup display by pressing the SET UP key in the DISPLAY section of the front panel.

4.9.6.4 Capacitance Measurement Display

NOTE: When the capacitance measurement starts, a momentary short across the line discharges any capacitance present. It is recommended that voltage and current measurements be made prior to making a capacitance measurement.

Option .40 measures a change in voltage and the corresponding change in charge, and calculates the capacitance value. There are two measurement ranges used for capacitance measurements, a normal range and a high range. The normal range should be used for values below 5 microfarads. The high range extends the upper limit from 5 microfarads through 20 microfarads. This high range also increases the measurement time by a factor of four. Therefore, the high range is more susceptible to change in foreign voltage or background interference during the measurement interval.

With CAP selected in the VOM/CAP Setup Display, press the MEAS key in the DISPLAY section of the front panel. The Capacitance Measurement Display appears as shown in Figure 4-77. Press the soft key below the desired input configuration; tip-to-ring, tip-to-sleeve, or ring-to-sleeve. The default setting is T-R.



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Figure 4-77. Capacitance Measurement Display

CAUTION: During operation, a 100 Vdc source is applied periodically through approximately 100 kilohms to the line under test. A high residual voltage may be left on a capacitance being measured.

With NORM selected, connect the line under test to the NORM SEND (2W) jack in the TEST LINE section of the front panel. With REV selected, connect the line under test to the NORM RCV jack.

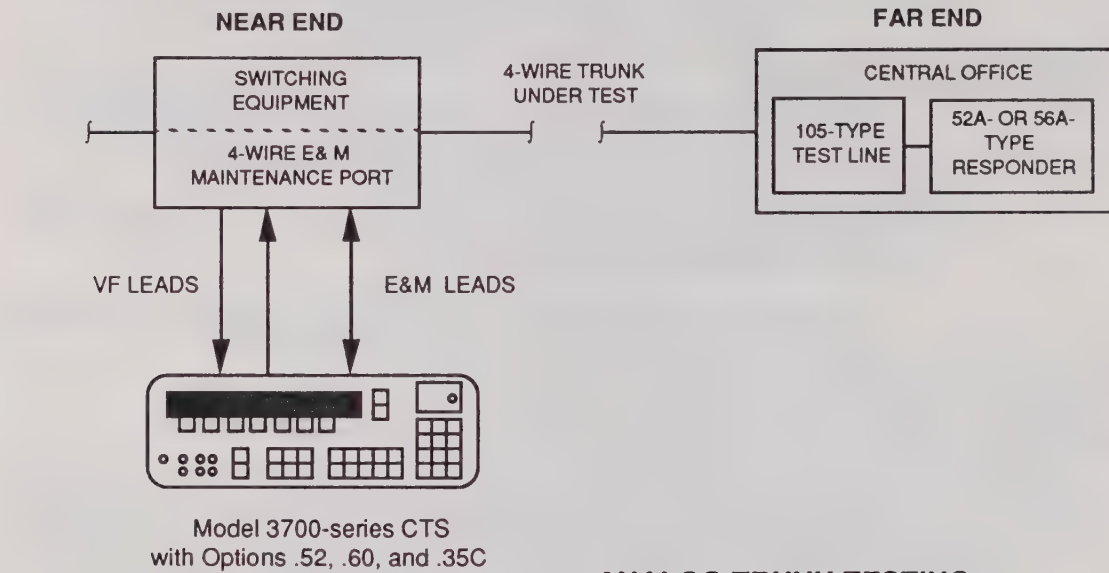
Press the seventh soft key to select the desired range. The measurement results display to three significant digits.

To change measurement mode, return to the setup display by pressing the SET UP key in the DISPLAY section of the front panel.

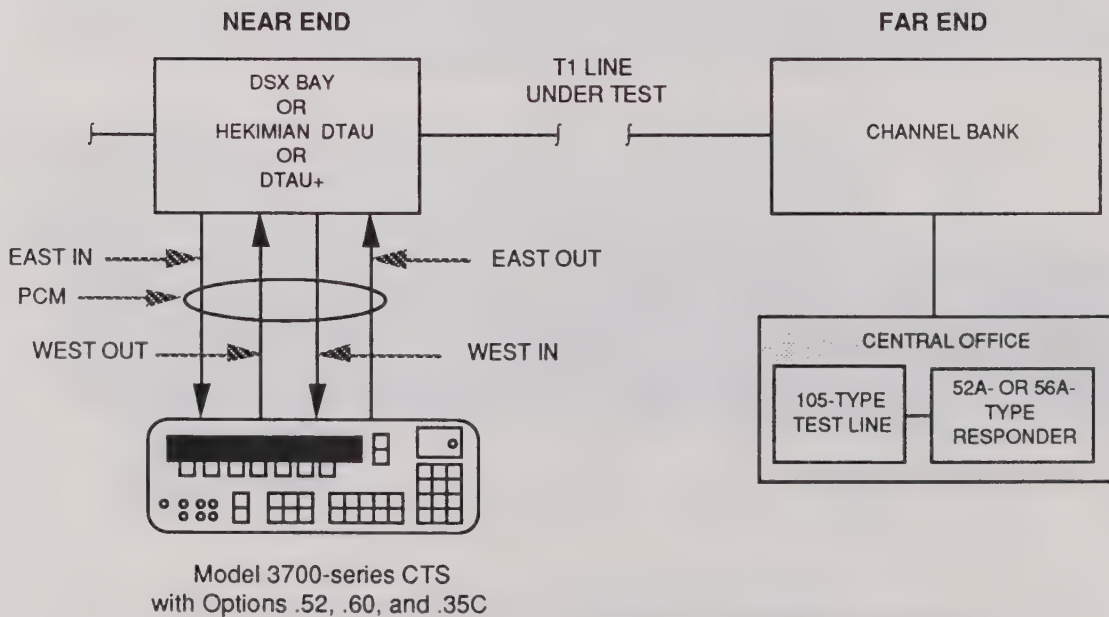
4.9.7 Responder Interface (Option .52)

This section describes the operating procedures for Option .52 Responder Interface. Option .52 enables the CTS to function as a near-end responder for two-way testing of 105-type test lines. (See Figure 4-78.) The option provides two-way measurements of loss, gain slope, C-message noise, noise-with-tone (C-notch), echo return loss (ERL), low frequency singing point return loss (SRLLO), and high frequency singing point return loss (SRLHI). Two-way self-checks are also supported. Individual tests can be selected and executed using the front-panel soft keys. Test results display following execution of the selected test. The results of previous measurements can be recalled as needed.

Option .52 is fully compatible with 52A- and 56A-type responders, and is designed to meet the requirements of Bellcore Compatibility Bulletin CB 106. Option .52 requires Option .60 DTMF/MF Signaling. Option .60 is a standard feature of all units with Firmware Revision 12 or later. It may also be desirable to have Option .35A or .35C Call Progress and Signaling for remote-control applications.



ANALOG TRUNK TESTING



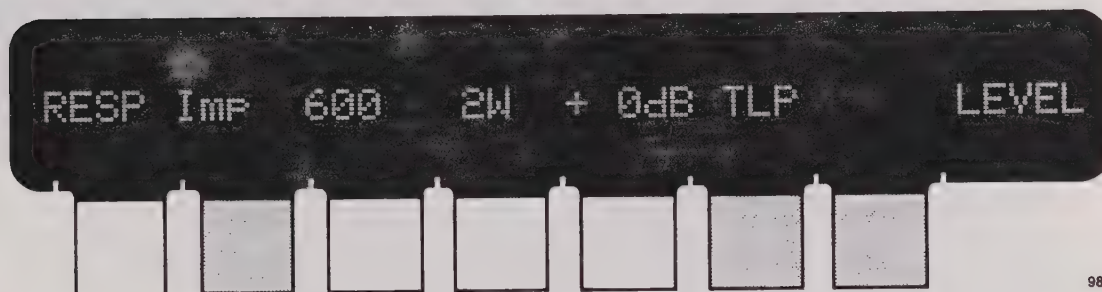
DIGITAL TRUNK TESTING

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Figure 4-78. Responder Interface Test Connections

4.9.7.1 Responder Interface Setup Display

To set up the responder interface option, press the LEVEL key in the MEASUREMENT section of the front panel and then the SET UP key until the Responder Interface Setup Display appears as shown in Figure 4-79.



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Figure 4-79. Responder Interface Setup Display

Responder Setup: Press the soft key below resp; the display changes to RESP. The responder is now in the setup mode.

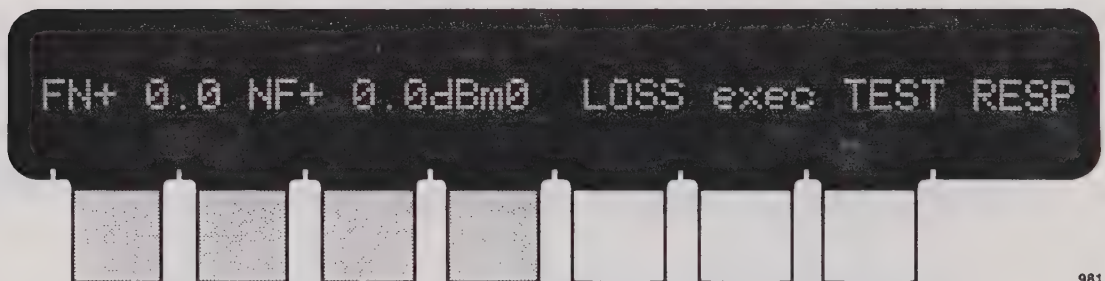
4W/2W Selection: Press the fourth soft key to toggle the unit between 4W and 2W operation.

Impedance Selection: If 2W operation is selected, the termination impedance of the line interface may be toggled between 600 ohms, 900 ohms, 1200 ohms, and external by pressing the third soft key. For 4W operation, the proper terminations are established in the line interface setup display.

TLP Setup: To enter a TLP, press the fifth soft key. Using the keypad, enter a "+" or "-" sign, then the most-through-least significant digits. The TLP may be set between +10 and -40 dB. Enter 0 dB for absolute measurements.

4.9.7.2 Responder Interface Measurement Display

With RESP selected in the Responder Interface Setup Display, press the MEAS key in the DISPLAY section of the front panel. The Responder Interface Measurement Display appears as shown in figure 4-80.



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Figure 4-80. Responder Interface Measurement Display

Measurement Display: The left half of the measurement display contains the results of the test indicated above the fifth and seventh soft keys. If the indicated test has not yet been performed, or if the test results are invalid, asterisks are displayed in place of the digits. Underrange and overrange test results are identified with minus and plus signs, respectively.

Test results for loss and gain slope are displayed in two parts: far-to-near measurements and near-to-far measurements, followed by the unit of measure if the receive TLP is 0 dB. If the receive TLP is other than 0 dB, the display shows dBm0.

The near-end noise (NEN) and far-end noise (FEN) measurements follow the same format as noise-with-tone, except the results for each direction are displayed separately.

Test results for return loss measurements display in two parts: near-end return loss and far-end return loss.

Test Type Selection: The display above the fifth soft key indicates the type of measurement that is to be performed. Pressing the fifth soft key advances the display through each of the following tests performed by the responder interface:

- LOSS for loss at 1 kHz
- GS04 for gain slope at 400 Hz
- GS10 for gain slope at 1 kHz
- GS28 for gain slope at 2.8 kHz
- NWT for noise-with-tone
- NEN for near-end noise
- FEN for far-end noise
- SRLO for low frequency return loss
- ERL for echo return loss
- SRHI for high frequency return loss
- ALL to perform all.

Test Execution: Pressing the sixth soft key causes a test to be executed as indicated by the display over the fifth and seventh soft keys. The display above the sixth soft key changes from exec to EXEC for the duration of the test.

Test Mode Selection: The display above the seventh soft key indicates the selected measurement mode. Pressing the seventh soft key advances the mode through three possible states: TEST, RLSE, and SCHK. TEST allows a measurement to be performed after pressing the exec soft key. SCHK indicates that a self-check measurement may be performed by both the far-end responder and Option .52. Pressing the exec soft key with RLSE displayed causes the far-end test line responder to release the line under test (go on-hook).

Performing a Test: Press the front-panel switch marked DIAL/TALK to place a call to the far-end responder. Press the "-" key on the keypad to terminate the present call. Press the "+" key on the keypad to initiate a new call. After placing a call to the far-end responder, press the LEVEL key and then the MEAS key to return to the responder measurement display. On entry to the measurement display, Option .52 looks for TPT (test progress tone). If TPT is received within three seconds, the message TPT displays above the third soft key for as long as TPT is present. When TPT is no longer present, the sixth and seventh soft keys become active and testing continues.

4.9.8 T1 Bit Error Ratio (Option .65)

This section describes the operating procedures for performing out-of-service PCM bit-error ratio measurements using the Option .65 T1 Bit Error Ratio. The Option .65 is capable of operation at the DS1 rate (1.544 Mbps) or at the channelized rate (64 kbps). The Option .65 works in conjunction with the Option .64 ESF PCM Test/Channel Access.

A PCM bit error ratio measurement replaces the PCM traffic with a pseudorandom test pattern at one end of the circuit, and then compares the pattern received to the test pattern. If a loop-back device such as a Channel Service Unit (CSU) or Smart Jack (SMJ) is installed in the

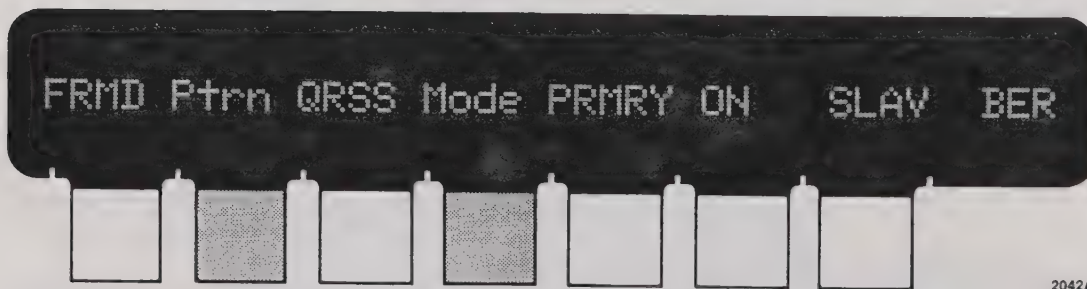
circuit, the test can be performed with a single test set. The Option .65 generates a variety of pseudorandom test patterns, user-defined patterns, all ones, alternating ones and zeros, 3-in-24 stress pattern, as well as CSU and SMJ loopup and loopdown codes. For the channelized rate, Remote Data Loopback (RDL) or DS0A latching loopback (OCU, CSU, and DSU) codes are generated according to CCITT Recommendation V.54. For the DS1 rate of 1.544 Mbps, Remote Data Loopback 1 (RDL1) codes are generated.

The Option .65 also provides a unique frequency difference measurement which shows the difference in frequency between either recovered clock and the internal clock, or between the two recovered clocks. This measurement is useful when troubleshooting clock synchronization problems that may cause slips. The Option .65 also provides error injection features, and in channelized, a round-trip delay measurement. The round-trip delay measurement is made in conjunction with a far-end loopback at either the primary rate or the channelized rate.

The Option .65 pattern generator is connected to the send direction selected in the PCM Signaling and Control Measurement Display. The pattern receiver of the Option .65 is connected to the from direction selected in the same display. The Option .65 is activated by the selection of PTRN in PCM Setup Display 2.

4.9.8.1 Bit Error Ratio Setup Display 1

To perform an out-of-service bit error ratio measurement, first set up the parameters of the Option .65 by pressing the PCM key in the MEASUREMENT section of the front panel. Press the SET UP key in the DISPLAY section until Bit Error Ratio Setup Display 1 appears as shown in Figure 4-81.



2042A

Figure 4-81. Bit Error Ratio Setup Display 1

Framing Selection: The first soft key selects framed (FRMD) or unframed (UNFR) output from the Option .65 pattern generator. The type of framing, such as D3/D4 or ESF, is selected in PCM Setup Display 2. The pattern receiver deletes the framing bits when framed output is selected.

Pattern Selection: The third soft key selects the type of pattern to be generated and received. The selections include the following:

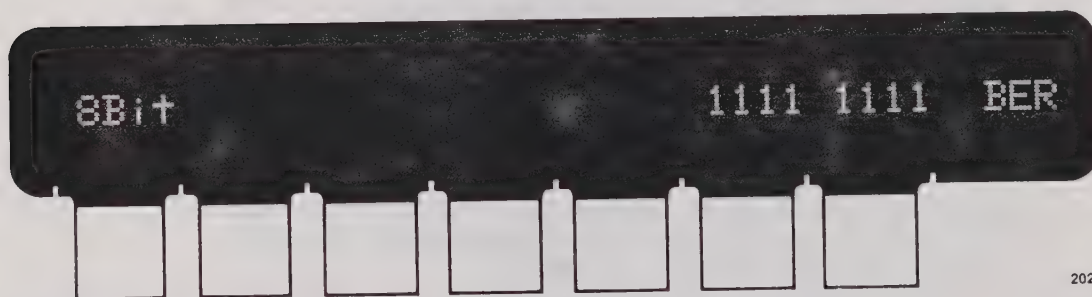
- QRSS for $2^{20}-1$ plus 14 zero suppression
- 511 for 2^9-1 pseudorandom pattern
- 2047 for $2^{11}-1$ pseudorandom pattern
- 2E15 for $2^{15}-1$ pseudorandom pattern
- 2E20 for $2^{20}-1$ pseudorandom pattern
- 2E23 for $2^{23}-1$ pseudorandom pattern
- ALL1 for all ones
- ALT for alternating ones and zeros (primary only)
- 3/24 for 3-in-24 stress pattern (primary only)
- USER for user-defined.

Mode Selection: The fifth soft key selects the primary (PRMRY) rate of 1.544 Mbps or the channelized (CHNNL) rate of 64 kbps. In primary rate, the whole DS1 is replaced with the selected pattern; in channelized, only one of 24 time slots has the pattern inserted. The channel is selected in the PCM Signaling and Control Display. If primary (PRMRY) rate is selected, the sixth soft key selects the PCM send output in the selected to direction. The selections are ON, THRU, or OFF. If channelized (CHNNL) is selected, then an additional selection for B8=1 (56-kbps) or clear (CLR) channel (64-kbps) appears over the sixth soft key.

Clock Source Selection: The seventh soft key selects the clock source for the send pattern generator if in the inline mode. If slave (SLV) is selected, then the send clock source is from the selected receive side, as determined in the PCM Signaling and Control Display. If master (MSTR) clock is selected, then the Option .64 internal clock source runs the send pattern generator.

4.9.8.2 User-Defined Pattern Setup
Display

After selecting user-defined pattern (USER) in Bit Error Ratio Setup Display 1, press the SET UP key. The User-Defined Pattern Setup Display appears as shown in Figure 4-82.



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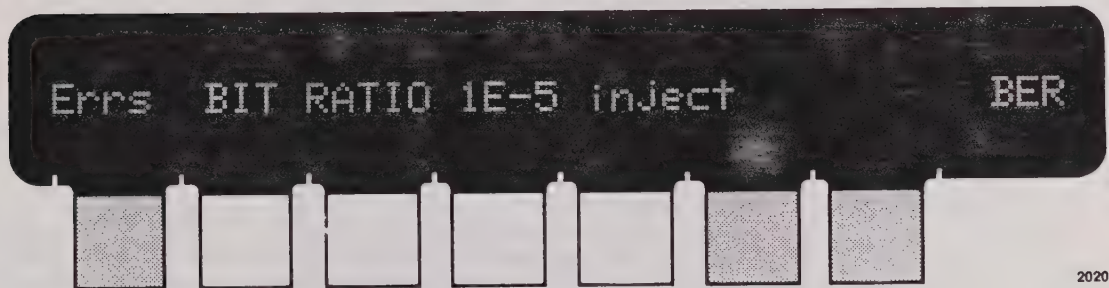
Figure 4-82. User-Defined Pattern Setup Display

Pattern Length Select: The first soft key selects a pattern length of 8, 16, or 24 bits.

User-Defined Pattern Entry: For an 8-bit user-defined pattern, the sixth and seventh soft keys select the group of four bits to be entered. Note that in channelized, the last bit (B8) always is a 1. For a 16-bit pattern, soft keys four, five, six, and seven are used to select the group of four bits to be entered; for a 24-bit pattern, soft keys two, three, four, five, six, and seven are used. The keypad "1" and "0" keys are used to enter the code. The pattern is transmitted byte aligned with the framing pattern if framed (FRMD) is selected in Bit Error Ratio Setup Display 1.

4.9.8.3 Bit Error Ratio Setup Display 2

It is sometimes useful to inject different error types into the send pattern. For this purpose, press the SET UP key in the DISPLAY section if the front panel until Bit Error Ratio Setup Display 2 appears as shown in Figure 4-83.



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Figure 4-83. Bit Error Ratio Setup Display 2

Error Type Selection: If primary (PRMRY) rate is selected in Bit Error Ratio Setup Display 1, the second soft key selects the following types of injected errors:

- BIT for bit error (any bit)
- BPV for bipolar violation (line code error)
- FBIT for framing bit error.

If channelized (CHNNL) rate is selected, then only pattern (PTRN) errors may be injected, and the second soft key is disabled.

Error Injection Mode: The third soft key selects either a fixed bit error ratio injection (RATIO) or a programmable quantity of errors (QTY).

Error Ratio or Quantity Entry: If RATIO is selected, then pressing the fourth soft key permits the entry of the mantissa and exponent of the error ratio. The mantissa is entered first; it can be 1, 2, or 5. The exponent is entered next; it can be from -3 to -9. The highest ratio possible is 2×10^{-3} and the lowest is 1×10^{-9} .

If QTY is selected, then pressing the fourth soft key permits the entry of the quantity of errors to be injected. The quantity can be from 1 through 99 errors.

Error Injection Control: If RATIO is selected, pressing the fifth soft key toggles error injection on and off. When INJECT appears in uppercase letters, error injection is on. When inject appears in lowercase letters, error injection is off.

If QTY is selected, pressing the fifth soft key causes inject to change to uppercase letters until the specified quantity of errors is injected. QTY then returns to lowercase letters. Pressing the fifth soft key again causes the specified quantity of errors to be injected.

4.9.8.4 Bit Error Ratio Measurement Display

Once the setup of the Option .65 parameters has been completed, and the appropriate to and from directions have been selected in the PCM Signaling and Control Display, then the Option .65 pattern generator is activated by selecting PTRN in PCM Setup Display 2.

To perform a timed bit error ratio test, press the PCM key in the MEASUREMENT section of the front panel, and then press the MEAS key until the Bit Error Ratio Measurement Display appears as shown in Figure 4-84. This display is very similar to the PCM Performance Measurement Display.



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Figure 4-84. Bit Error Ratio Measurement Display

Bit Error Ratio and PCM Performance Results: The left area of the display shows the results of the bit error ratio measurement and the PCM performance totalizers. The third and fourth soft keys step backward and forward, respectively, through the results list. The results are initialized at the beginning of a timed test, and remain available after a test has ended, until a new test starts. Results are listed as follows:

- BIT ER RATIO for bit error ratio
- BIT ERROR for bit errors
- BPV RATIO for bipolar violation ratio (primary only)
- BPV for bipolar violations (primary only)
- FRAME ERROR for frame bit errors (primary, framed only)
- MFAS ERROR for multiframe bit errors (primary, SF, framed only)
- CRC ERROR for CRC errors (primary, ESF, framed only)
- FRAME ALARM for frame alignment signal alarms (primary, framed only)
- FRM LOS SEC for framing loss seconds (primary, framed only)
- NO PCM ALARM for no PCM alarms (primary only)
- EXCESS 0'S for excessive zeros (primary only)
- REMOTE ALARM for remote alarms (primary, framed only)
- PTRN SLIP for pattern slips (channelized, framed only)
- PTRN SYN LOS for pattern synchronization losses
- PTRN LOS SEC for pattern loss seconds
- ASY ERD SEC for asynchronous errored seconds
- SYN ERD SEC for synchronous errored seconds
- AS SV ER SEC for asynchronous severely errored seconds
- SY SV ER SEC for synchronous severely errored seconds
- DEGRADED MIN for degraded minutes
- UNAVAIL SEC for unavailable seconds
- AS ER FR SEC for asynchronous error free seconds
- SY ER FR SEC for synchronous error free seconds.

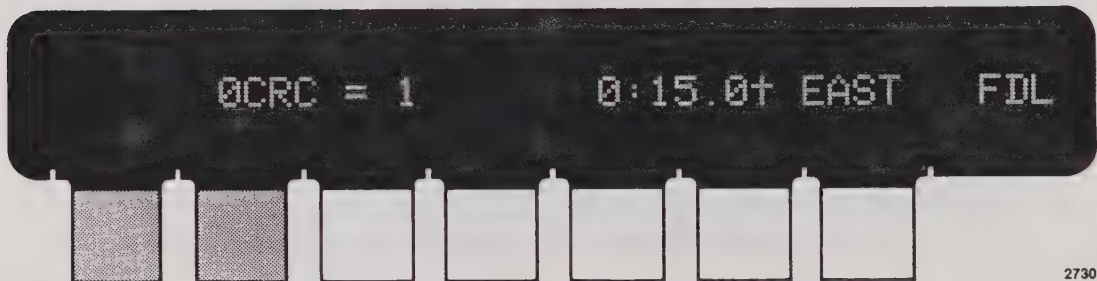
Timed Test Duration Set: The performance test timer can be set for any duration from 0.1 minutes to 100 hours, with default set to 15 minutes. To set the timer duration, press the fifth soft key. Enter the most-through-least significant digits of hours, minutes, and then tenths of minutes using the keypad.

Timed Test Start/Stop: The performance test timer starts and stops by pressing the sixth soft key, directly below the label T. When the label is in lowercase, the timer is stopped. When the label is in uppercase, the timer is running. After timing out, uppercase T reverts to lowercase, and the accumulated results and test duration display.

Test Result Direction Selection: In the inline or terminal modes, the measurement results display for the selected from direction, either east or west. In the direction not selected, the standard performance totalizers display. In the DCS mode, there is a single DS1, therefore, there is no test result direction selection.

4.9.8.5 ESF FDL Performance Monitor Measurement Display

If ESF is the selected channel format, the ESF FDL (facility data link) performance monitor results may be viewed by pressing the MEAS key until the ESF FDL Performance Monitor Display Appears as shown in Figure 4-85. A timed ESF FDL performance monitor test is performed in parallel with every bit error ratio test.



2730

Figure 4-85. ESF FDL Performance Monitor Measurement Display

ESF FDL Performance Monitor Results: The left area of the display shows the results of the ESF FDL performance monitor measurement, accumulated from the ANSI T1.403 performance report messages on the DS1 facility data link. The third and fourth soft keys step backward and forward, respectively, through the results list. The results are initialized at the beginning of a timed test, and remain available after a test ends, until a new test starts. Results are listed as follows:

- CRC=1 for total seconds with one CRC error
- CRC=2-5 for total seconds with 2-5 CRC errors
- CRC=6-10 for total seconds with 6-10 CRC errors
- CRC=11-100 for total seconds with 11-100 CRC errors
- CRC=101-319 for total seconds with 101-319 CRC errors
- CRC>319 for total seconds with more than 319 CRC errors
- FRAME SYNC for total seconds with at least one severely errored framing event
- FRAME BIT for total seconds with at least one frame bit error violation
- LINE CODE for total seconds with at least one line code violation
- SLIP for total seconds with at least one slip count

- DISCARD SEC for seconds discarded for no received performance report
- ERRORED SEC for errored seconds
- SEV ERD SEC for severely errored seconds
- UNAVAIL for unavailable seconds
- ERR FREE SEC for error free seconds.

Timed Test Duration Set: The performance test timer can be set for any duration from 0.1 minutes to 100 hours, with default set to 15 minutes. To set the timer duration, press the fifth soft key. Enter the most-through-least significant digits of hours, minutes, and then tenths of minutes using the keypad.

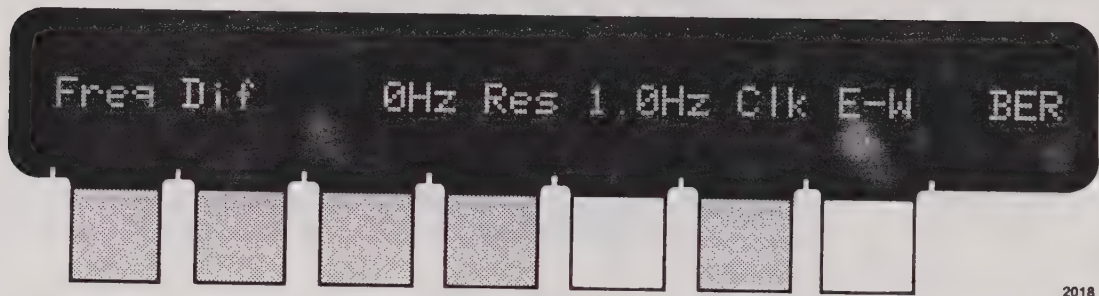
Timed Test Start/Stop: The performance test timer starts and stops by pressing the sixth soft key, directly below the label T. When the label is in lowercase, the timer is stopped. When the label is in uppercase, the timer is running. After timing out, uppercase T reverts to lowercase, and the accumulated results and test duration display.

Test Result Direction Selection: In the inline or terminal modes, the measurement results display for the selected from direction, either east or west. In the direction not selected, the standard performance totalizers display. In the DCS mode, there is a single DS1, therefore, there is no test result direction selection.

4.9.8.6 Frequency Difference Measurement Display

If the Option .65 is installed, press the PCM key in the MEASUREMENT section of the front panel, and then press the MEAS key in the DISPLAY section until the Frequency Difference Measurement Display appears as shown in Figure 4-86. This measurement displays the difference in frequency between the two recovered clock signals, EAST IN or WEST IN PCM jacks, or between either of the recovered clocks and the internal clock of the Option .64. This measurement is useful when troubleshooting clock synchronization problems which may cause slips.

If a CTS is placed in series with a digital PCM circuit between a DCS (timing source) and a channel bank (loop timed), then the frequency difference between the two recovered clocks must be 0 Hz on the average. If the channel bank is mistakenly set for master timing, steady frequency differences between the clock signals to and from the channel bank are measured.



2018

Figure 4-86. Frequency Difference Measurement Display

Frequency Difference Display: The left area of the display shows the frequency difference measurement result in Hertz. The frequency range is 0 through 9999 Hz, or 0 through 999.9 Hz. If one of the signals selected for measurement is absent, then NOPCM replaces the measurement result.

Frequency Difference Measurement Resolution Selection: The frequency difference measurement can be made with a 1-Hz resolution with a 1-second measurement period, or with a 0.1-Hz resolution with a 10-second measurement period. The fifth soft key makes this selection.

Clock Source Selection: The seventh soft key selects between the following clock sources:

- E-W for EAST IN and WEST IN clocks
- E-I for EAST IN and internal clocks
- W-I for WEST IN and internal clocks.

4.9.8.7 CSU/SMJ/RDL Loopback Measurement Display

In order to provide a convenient means of testing toward a remote terminal, Channel Service Units (CSUs) and Smart Jacks (SMJs) provide a loopback capability which aids in sectionalizing a circuit failure. The Option .65 provides a feature to activate and deactivate these loop-back devices. In addition, if a channelized rate (64 kbps or 56 kbps) is selected in Bit Error Ratio Setup Display 1, then Remote Data Loopback (RDL) or DS0A latching loopbacks (OCU, CSU, DSU) can be commanded in accordance with CCITT Recommendation V.54. For a primary rate of 1.544 Mbps, Remote Data Loopback 1 (RDL1) can be commanded.

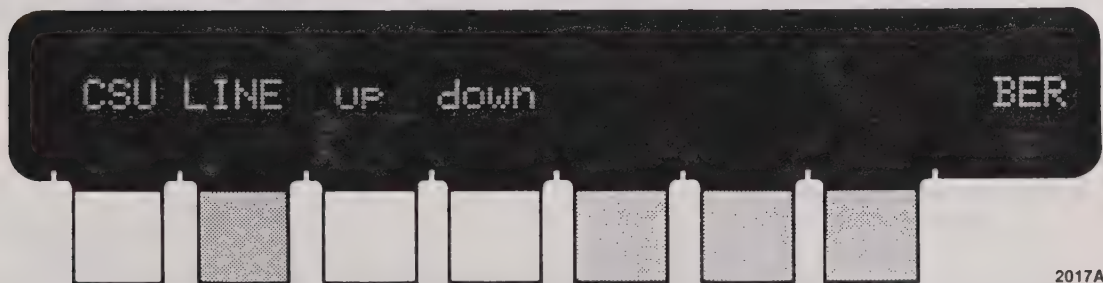
NOTE: The circuit must be equipped with a data service unit which conforms to this recommendation.

For a superframed CSU or SMJ, a repetitive 5-bit code (10000, 11000) transmits for six seconds, in place of the traffic, to cause a line loopback. Once a line loopback is established, a 3-bit code (100) transmits to release the loopback on a CSU, and a different 5-bit code (11100) transmits to release the loopback on an SMJ.

For an ESF CSU or SMJ, the Facility Data Link (FDL) is used to transmit the loop-back control commands, rather than a fixed code in place of the traffic. In addition, for CSU and SMJ line loopbacks, the 5-bit and 3-bit codes are transmitted on the payload in addition to the FDL bit oriented message. The three sets of FDL loop-back commands presently defined are as follows:

- Line loopback activate (CSU) for 00001110 11111111
- Line loopback deactivate (CSU) for 00111000 11111111
- Payload loopback activate (CSU) for 00010100 11111111
- Payload loopback deactivate (CSU) for 00110010 11111111
- Network loopback activate (SMJ) for 00010010 11111111
- Network loopback deactivate (SMJ) for 00100100 11111111.

The special loop-back display is accessed by pressing the PCM key in the MEASUREMENT section of the front panel, and then pressing the MEAS key in the DISPLAY section until the CSU/SMJ/RDL Loopback Measurement Display appears as shown in Figure 4-87.



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Figure 4-87. CSU/SMJ/RDL Loopback Measurement Display

CSU/SMJ/RDL Selection: The first soft key selects the type of device providing the loopback. If primary (PRMRY) rate is selected in Bit Error Ratio Setup Display 1, CSU, SMJ, or RDL1 may be chosen. If channelized (CHNNL) is selected, then RDL, or OCU, CSU, and DSU DS0A latching loopbacks may be selected.

Loopback Type Selection: If ESF is selected in PCM Setup Display 2, primary (PRMRY) is selected in Bit Error Ratio Setup Display 1, and CSU is selected with the first soft key, then the second soft key selects either a line (LINE) or a payload (PLD) loopback. A line loopback returns every bit unmodified, while a payload loopback strips the old framing and generates new framing, while passing the channel data through unchanged.

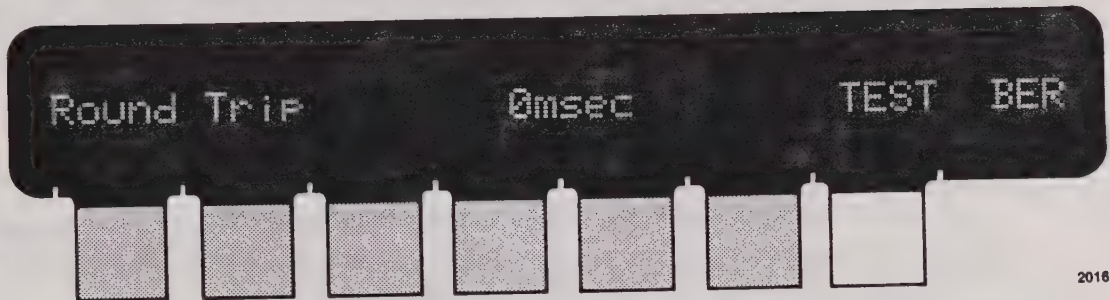
If channelized (CHNNL) is selected in PCM Setup Display 2, and DS0A CSU is selected with the first soft key, then the second soft key selects the sequence to perform a CSU loopback with none, one, or two 56-kbps repeaters in the loop. If no repeaters are in the loop, NDEV0 is selected; for one repeater, NDEV1 is selected; for two repeaters, NDEV2 is selected.

Loopback Activation: To command the loopback activation, press the soft key below up. The display changes to UP and the loopback activation code or message transmits for at least six seconds, or until the key is released. The message CSU LOOPUP, SMJ LOOPUP, RDL LOOPUP, RDL1 LOOPUP, or MAP0, MAP1, or FAIL appears at the right side of the display. If the Option .65 detects no loopback, then the right side of the display remains blank.

Loopback Deactivation: To drop the loopback once activated, press the soft key below down. The display changes to DOWN, and the loopback deactivation code transmits for six seconds. The message CSU LOOPDN, SMJ LOOPDN, RDL LOOPDN, RDL1 LOOPDN, OCU LOOPDN, DSU LOOPDN, or FAIL appears at the right side of the display when the Option .65 detects that the send signal differs from the receive signal.

4.9.8.8 Round-Trip Delay Measurement Display

To perform a channelized round-trip delay measurement, first the channel (64 kbps or 56 kbps) or the entire T1 circuit must have a loopback activated. Once the loopback is active, enter the round-trip delay measurement display, by pressing the PCM key in the MEASUREMENT section of the front panel, and then the MEAS key in the DISPLAY section until the display appears as shown in Figure 4-88.



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Figure 4-88. Round-Trip Delay Measurement Display

Round-Trip Delay Measurement Results: In the center of the display area, the round-trip delay measurement results appear after proper synchronization of the send and receive signals. When the test is active, the flag SYNCHRONIZING appears until synchronization occurs, then ****msec appears until the measurement results are presented. The measurement range is 0 through 1050 ms; if this range is exceeded, ++++msec appears. If the T1 signal is lost, then NO SYNC-NOPCM appears. If there is difficulty synchronizing, then NO SYNC-PATTERN or NO RESPONSE appears. The measurement resolution is 1 ms.

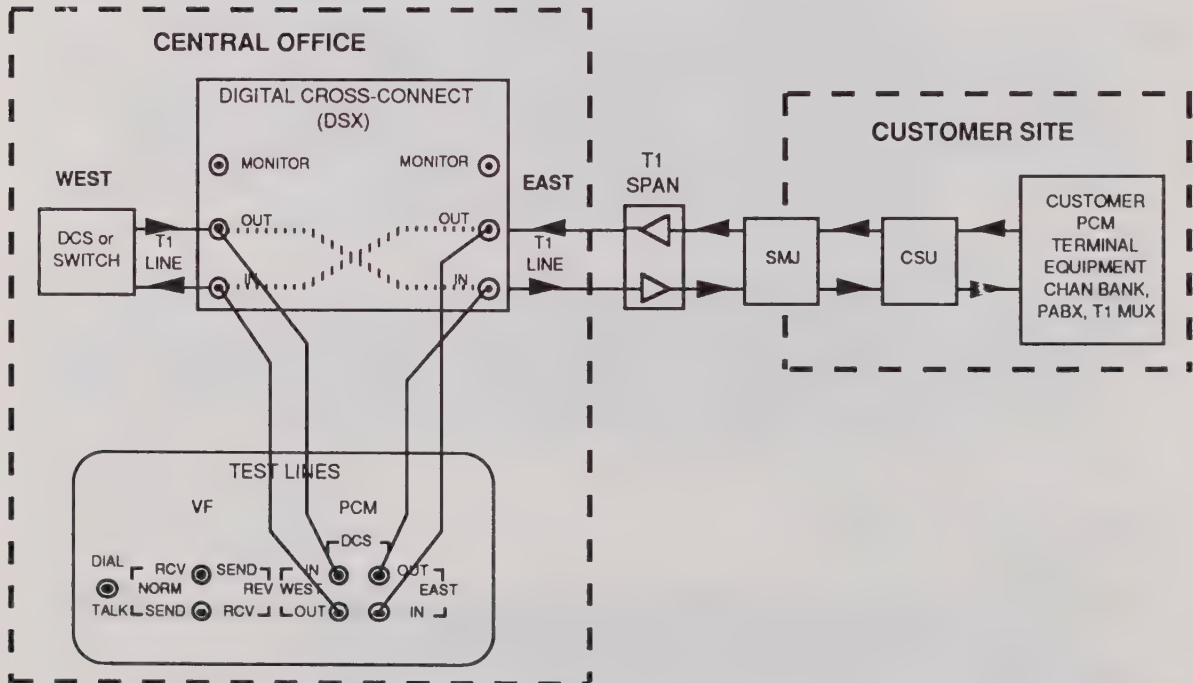
Round-Trip Delay Test Activation: To initiate a round-trip delay measurement, press and release the soft key below test. The display changes to TEST and the synchronization process takes place for up to 10 seconds. The test results display for one second, then disappear. If the seventh soft key is held down, then the test repeats continuously, about once every two seconds.

4.9.8.9 Sample Out-of-Service Testing

This section provides typical examples of two common testing scenarios; one-way loopback and the office-to-office.

One-Way Loopback Test: The one-way loop-back test normally is performed from a central office toward the customer premises. To perform the one-way loop-back test, place the CTS in the typical inline connection as shown in Figure 4-89 and proceed as follows:

Step	One-Way Loopback Test Example (continued)
1	Press the PCM key in the MEASUREMENT section of the front panel to display Inline PCM Setup Display 1. Press the second soft key to select ON, and the third soft key to select INLIN.
2	Press the SET UP key in the DISPLAY section of the front panel to display PCM Setup Display 2. Verify that AMI and D3D4 are selected.
3	Press the SET UP key until Bit Error Ratio Setup Display 1 appears, and select the pattern to be transmitted. Be sure that PRMRY is selected, and select MSTR clock with the seventh soft key.
4	Press the MEAS key until the PCM Signaling and Control Display appears. Select to east (To E) and from east (FE). Check for the presence of any PCM alarms.



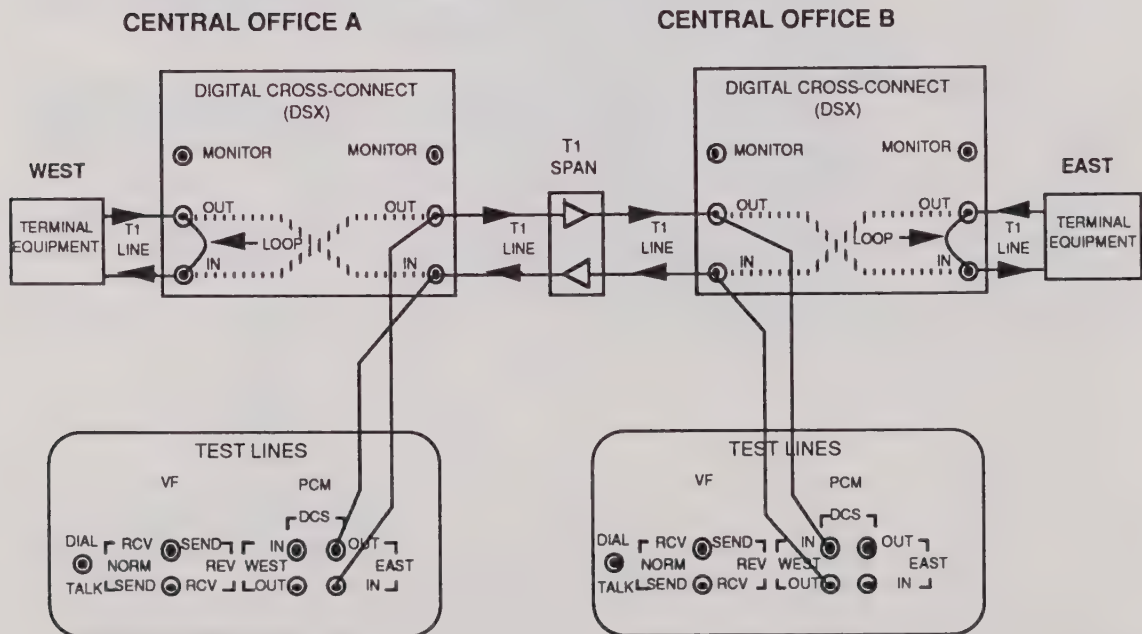
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Figure 4-89. Typical One-Way Loopback Test

Step	One-Way Loopback Test Example (continued)
5	To take the line out of service, press the SET UP key until PCM Setup Display 2 appears, then press the sixth soft key until PTRN appears.
6	To set a loopback from the CSU, press the MEAS key until the CSU/SMJ/RDL Loopback Measurement Display appears. Select CSU, then press the soft key below up. After several seconds, the message CSU LOOPUP should appear, and the circuit is ready for testing.
7	Press the MEAS key until the Bit Error Ratio Measurement Display appears. Select the EAST direction with the seventh soft key.
8	Enter the test time duration using the fifth soft key. The default is 15 minutes.
9	Start the test by pressing the sixth soft key below t. If everything is correct, the pattern receiver synchronizes, and the test proceeds.
10	When the test duration set earlier has passed, the timer stops the test and signals the operator with a long-duration key tone. The results of the test can be observed during or after the test by pressing the third and fourth soft keys to step through the test results.
11	When testing is complete, the circuit must be restored by deactivating the CSU loopback. Press the MEAS key until the CSU/SMJ/RDL Loopback Measurement Display appears. Press the soft key below down. After several seconds, CSU LOOPDN should appear.
12	To restore the circuit to service, press the SET UP key until PCM Setup Display 2 appears. Press the sixth soft key until MON appears. The circuit now is restored to service.

Office-to-Office Test: An office-to-office test is an out-of-service test performed with two Model 3700-series CTSs equipped with Option .65. First set up the test sets as shown in Figure 4-90, then proceed as follows:

Step	Office-to Office Test Example
1	At both offices, press the PCM key in the MEASUREMENT section of the front panel, then press the second soft key to select ON and the fourth soft key to select TRML.
2	At both offices, press the SET UP key to display Terminal PCM Setup Display 2, and verify that AMI and D3D4 are selected. Press the fourth soft key to select MSTR clock source.
3	At both offices, press the SET UP key until Bit Error Ratio Display 1 appears, and select the pattern to be transmitted. With PRMRY selected, select MSTR clock using the seventh soft key.



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Figure 4-90. Typical Office-to-Office Test

Step	Office-to Office Test Example (continued)
4	At central office A, press the MEAS key until the PCM Signaling and Control Display appears. Select to east (To E) and from east (FE). Check for the presence of PCM from east, and any PCM alarms.
5	At central office B, press the MEAS key until the PCM Signaling and Control Display appears. Select to west (To W) and from west (FW). Check for the presence of PCM from west and any PCM alarms.
6	At both offices, press the SET UP key until PCM Setup Display 2 appears. Press the sixth soft key until PTRN appears, starting the pattern generator.
7	At central office A, press the MEAS key until the Bit Error Ratio Measurement Display appears, then select EAST with the seventh soft key.
8	At central office B, press the MEAS key until the PCM Performance Measurement Display appears, then press the seventh soft key to select WEST.
9	At both offices, enter the test time duration using the fifth key, unless the default duration (15 minutes) is desired.
10	At both offices, start the test by pressing the sixth soft key below t. If everything is correct, the pattern receiver synchronizes, and the test begins.
11	When the test duration has passed, the timer stops the test and signals the operator with a long-duration key tone. The results of the test can be observed during or after the test by pressing the third and fourth soft keys to step through the test results.

SECTION 5. REMOTELY CONTROLLED OPERATION

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5.1 Introduction

This section provides instructions for remotely controlled operation of units equipped with Option .25A-232 Remote Control. Instructions for using the following options are also included in this section:

- Option .41 Master/Slave
- Option .71-002 Master/Slave EasyTest
- Option .71-007 Enhanced Master/Slave EasyTest
- Option .71-012 REACT EasyTest.

Option .25A-232 provides flexible remote-control capability for the Model 3700-series Communications Test Systems (CTSs). This option allows the CTS to be used in a wide variety of testing applications. The CTS can be used as a simple stand-alone system controlled by a data terminal, or as part of an integrated automated test system such as Hekimian's REACT 2000 System. This remote-control option contains a comprehensive software package that provides a set of commands to control the test set configuration and return measurement results through an EIA RS-232-C/CCITT V.24 serial interface. Interface connectors and configuration switches for this option are located on the rear panel of the unit.

NOTE: Prior to remote-control operation, the CTS interface DIP switch must be set up as described in the installation section of this manual.

5.2 RS-232-C Serial Interface

This section provides guidelines for operating a CTS through an RS-232-C serial interface. These guidelines should be reviewed prior to operating the unit.

Command entry begins when the Option .25A-232 sends a prompt (->), indicating that it is ready to receive a command. This option echoes each character as it is received to ensure correct command transmission and reception. The execution of a command is initiated by a carriage return <CR> (ASCII 0D). The option echoes the carriage return and then proceeds to execute the command. The option does not insert added delays on carriage return. When a command has been completed and the output data, if any, has been transmitted, a new prompt is sent.

If an error is made while entering a command and a carriage return has not been sent, a rubout or delete character (ASCII 7F) may be used to delete a character from the input buffer. The deleted character is echoed for clarity in place of the rubout character. A backspace (ASCII 08 or CTRL-H) may be used to perform the same function, but the deleted character is not echoed.

If it is desired to scrub the contents of the input buffer, sending a CTRL-D (ASCII 04) causes a new prompt to display. Characters transmitted to the option during collection of data are ignored (and not echoed) except for CTRL-A (ASCII 01), which scrubs the measurement in progress and returns a prompt.

5.3 Master/Slave Operation

This section contains instructions for master/slave operation. In master/slave operation, a *master* test set at one end of the line under test is used to control a *slave* test set at the other end of the line. Master/slave operation of the CTS requires Option .41 Master/Slave and Option .25A-232 Remote Control (RS-232-C).

5.3.1 General Information

Option .41 Master/Slave provides control over a distant-end test set using only the 4W (4-wire) lines under test. Option .41 is a PC board which plugs into a short option slot in the CTS. Functionally, the option is a special-purpose, 300-bps FSK (Frequency Shift Keying) modem designed to distinguish between test signals and qualified modem signals. This is accomplished with a 103A-type modem sending and receiving on the original frequencies, and a 2.1-kHz pilot tone. The receive side includes level and frequency discrimination to recognize the modem and pilot signals. The modem is used to control the slave end and to send data back to the master end. Figure 5-1 is a typical master/slave configuration.

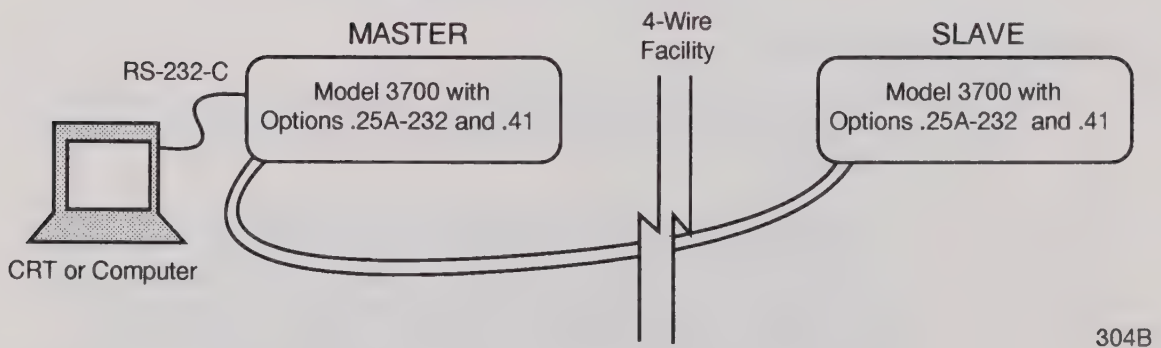


Figure 5-1. Master/Slave Configuration

5.3.2 Operating Procedures

Apply power to the instruments and CRT terminal. The CRT may be used to control the master unit using the remote communications commands described in this section. To communicate with the slave unit, type <ESC>S<CR>. A new prompt appears, and subsequent commands are executed by the slave unit.

The transmission path control character may be changed from <ESC> (ASCII 1B) to any control character (ASCII 00 to 1F except 01, 02, 03, 04, 08, 0D, 11, and 13). This change may be needed in systems where <ESC> has a defined function. The character is changed by the SESC command. An ASCII printing notation defines the control character. The character ↑ (ASCII E5) to indicate CTRL, followed by @ (ASCII 40) through ← (ASCII 5F), are used to map the ASCII 00 to 1F nonprinting characters. For example, if the desired path control character is BEL (ASCII 07), the command would be SESC ↑ G. The default character at powerup is <ESC> and is shown as ↑ I using the DESC command.

When making measurements at the slave end, the SDEL command must be used to delay the measurement until the modem signals are dropped, the test signals are restored to the input of the slave, and the measurement settles. The amount of delay required varies greatly in each measurement. For example, level is relatively fast, and no more than several seconds of delay would be necessary. However, measurements such as group delay, P/AR (peak-to-average ratio), or intermodulation distortion may require significantly longer times to ensure fully settled readings. Table 5-1 contains a list of suggested delay times.

Table 5-1. Recommended Delay Times

MEASUREMENT	NORMAL (sec)	DAMPED (sec)
Level/Frequency	2	4
Level/Frequency/SN	4	--
Noise	3	10
Impulse Noise	2	--
Hits/Dropouts	2	--
Group Delay	5	7
Amplitude Jitter	5	--
Phase Jitter	5	--
Intermodulation Distortion	10	--
P/AR	6	12
4W Return Loss	4	18

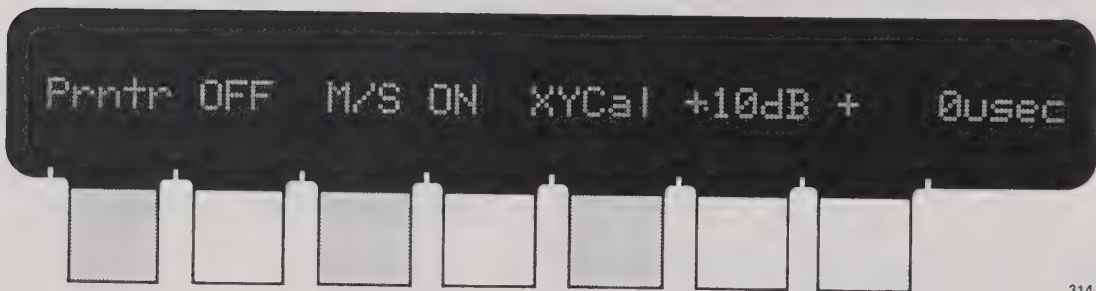
The send level for the Option .41 is set independently from the normal generator send level using the SMSL command. This feature allows quiet termination and variable test signal levels while ensuring reliable modem operation. The default value for the master/slave send level is -16 dBm.

NOTE: The actual send level is 3 dBrms (root-mean-square) above this level due to the addition of modem and pilot tones.

The SMSL command also has an OFF parameter which may be used to disable the master/slave capability during remote-control operation. This parameter is cleared on SCLR powerup, when using an <ESC>S sequence, or when using SMSL without the OFF parameter. During manual front-panel operation, the master/slave capability may be disabled by pressing the LINE key, followed by the "4" key on the keypad. Pressing the fourth soft key located below ON, as shown in Figure 5-2, replaces ON with OFF in the display indicating that master/slave operation is disabled.

To again enable the master/slave capability, press the fourth soft key located below OFF. ON replaces OFF in the display. The master/slave capability can also be enabled by turning the unit off, then on again.

The Option .41 at the master end can be self-tested by typing <ESC>S<CR> with the unit in internal loopback. The modem echoes characters from the CRT terminal through the Option .25A-232, to the Option .41 transmitter and the send side of the CTS. The modem signal is then looped back to the receive side of the CTS, and the Option .41 receiver to the Option .25A-232 and the CRT terminal.



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Figure 5-2. Master/Slave Enable Display

If executed by the slave unit, the following actions stop any further communication with the unit:

- Setting REV in SLIN, SDPS, SDDT, SDMF, SVMC, DIAL
- Setting LOOP in SLIN
- Setting 2W6, 2W9, 2W12, or 2W EXT in SRLS
- Setting NTG in SNSE or SSLV
- Activating PCM if on a VF channel or disabling PCM if on a PCM channel.

When the CTS is controlled in the slave mode, commands from the local port result in the error message E10 SLV MODE. Local control may override the slave mode (interrupting the master/slave test) by sending a CTRL-A. A new prompt appears and the unit responds to commands from the local port. To release a slave unit from the slave mode, the command SEXS is sent from the master to the slave set.

5.4 Commands and Output Formats

The commands for Option .25A-232 are composed of a three- to five-character alphabetical command followed by a parameter field of up to 76 characters. The first alphabetical character is a prefix used to define the function of the command:

- S-prefixed commands set parameters and/or a measurement type
- D-prefixed commands display parameter status
- M-prefixed commands start a measurement sequence.

The next three alphabetical characters describe the function and measurement definitions. These definitions appear in Table 5-2.

NOTE: During remote-control operation, a list of commands can be displayed by executing the HELP command. The HELP command can also be used to display a list of parameters for any command.

A measurement command does not need to be preceded by a set command, but if measurement parameters must be changed, then a set command is required. The delay at the entry of a measurement command also may not be adequate to ensure a stabilized reading; for example, a Bell standard plus low frequency jitter measurement may require up to 30 seconds to stabilize. In this case, the operator must insert delays. There is no delay on retrieving data on subsequent measurement commands of the same type. Refer to Table 5-3 for measurement timing information.

Table 5-2. Function and Measurement Definitions

COMMAND	FUNCTION/MEAS	COMMAND	FUNCTION/MEAS
ADN	Automatic Dial Number	IMP	Impulse Noise
AMJ*	Amplitude Jitter	LIN	Line Interface
BER*	Bit Error Ratio	LPS*	Loop-Start Signaling
BUF	Output Buffering	LVL	Level-Frequency-S/N Ratio
CAP	Capability	MFL	DTMF & MF Send Level
CLR	Initialization	MSL*	Master/Slave Send Level
CPG*	Call Progress	NON	No Signaling
DEL*	Slave Measurement Delay	NSE	Noise
DLY*	Envelope Delay	PAR*	P/AR
DMF	Dial (MF Signaling)	PCM*	PCM
DPS	Dial (Pulse Signaling)	PCS*	PCM Signaling
DTT	Dial (DTMF Signaling)	PHJ*	Phase Jitter
EIA	Serial Interface Param.	RLS	Return Loss
EMS*	E&M Signaling	RSP*	Responder Interface
ESC*	Path Control Character	RTD*	Round-Trip Delay
EXS*	Exit Slave Mode	RTT*	Receive Address Digits
FLV	Fast Level/Frequency	SFS*	SF Signaling
GSS*	Ground-Start Signaling	SND	Send Side
GTL	Go-to-Local	SUP*	Supervision
HDO*	Hits and Dropout	SWP	Sweep
IHD*	Impulse Noise, Hits/Dropouts	TIM	Real-Time Clock
IMD*	Intermodulation Distortion	VMC*	Volt/Ohm/Capacitance

*Requires options to be installed in the CTS

Table 5-3. Measurement Timing

MEASUREMENT	MEAS TIME (sec)	UPDATE (msec)
Level/Frequency	3.0	500
Level/Frequency/SN	6.0	700
Noise	4.5	350
Impulse Noise	3.0	--
Hit/Dropouts	3.0	--
Amplitude Jitter	5.5	500
Phase Jitter	5.5	500
Intermodulation Distortion	8.5	2500
P/AR	4.0	1000
Return Loss	5.0	300
VOM/CAP: V & MA	0.3	700
RESL	1.3	1600
RESH	6.0	3700
CAPL	2.0	1700
CAPH	6.0	3200
Clear (SCLR)	8.0	--
(SCLR W)	1.0	--

Following the three- to five-character command is the parameter field, which is used to enter numeric parameters and set measurement conditions. These parameters must be separated from the command and other parameter fields by a comma (ASCII 2C) and/or any number of spaces (ASCII 20).

Some parameters are momentary and automatically become false if an S command is executed without including the momentary parameter label. All other parameters remain the same if they are omitted from an S command; thus, only the parameters which are to be changed should be entered. For example, if an SLIN HOLD command is followed by an SLIN command, the HOLD function activates and automatically toggles off at the execution of the second command. Unless otherwise specified, the numeric parameter entries have the same range as in front-panel controlled operation.

The measurement commands normally consist of four alphabetic characters, except for special functions where input parameters are required for timed tests. As an example, "MIHD" (Measure Impulse Noise, Hits, and Dropouts) requires a measurement time and print-interval

time selection before the test can be performed. If these parameters are omitted, the returned display is the contents of the storage register, which may be zeros or the results of the last measurement.

The data output formats for the Option .25A-232 are always preceded by at least two character spaces. Also, each data parameter is separated from the next by two or more character spaces. Overrange is indicated by all numeric digits being replaced by plus (+) characters, and underrange by minus (-) characters. Whenever the reading is out of range completely, the numeric digits are replaced by asterisks (*). The maximum line length is 80 characters.

5.4.1 Control Commands (Option .41)

Control commands are used at various times during remote-control operation. Therefore, you should familiarize yourself with these commands before using the CTS in remote control. The following paragraphs describe these commands in detail.

CONTROL COMMANDS

Initialization Command:

SCLR WARM¹
W

(basic unit warm start, if no W or WARM parameter, a hardware reset is performed)

Go-to-Local Command: SCTL

Input Control Commands:

Backspace	RUBOUT (ASCII 7F), CTRL-H (ASCII 08)
Scrub Line	CTRL-D (ASCII 04)
Stop Measurement in Progress	CTRL-A (ASCII 01)
Restore Local Control from	
Slave Mode	CTRL-A (ASCII 01)
Stop PROC in Progress	CTRL-A (ASCII 01)
Stop Transmission (X off)	CTRL-S (ASCII 13)
Resume Transmission (X on)	Any character but CTRL-S (ASCII 13)
Resume Transmission (X on)	CTRL-Q (ASCII 11)

CONTROL COMMANDS (continued)

Display CTS Configuration Commands:

Model, Firmware Release, Capabilities: DCAP

```
COPYRIGHT 19XX HLI ALL RIGHTS RESERVED
HLI 3705 REV XYY.YY
.07      X-Y OUTPUTS
.08      4Z I/O
.09      20KHZ OPERATION
.10      120KHZ OPERATION
.11      IMPULSE NOISE
.12      ENV DELAY (for .12 or .12A)
.13      HITS/JITTER
.14      INTERMOD DIST
.15      NOISE FILTERS
.15B     NOISE FILTERS
.15C     NOISE FILTERS
.16      RETURN LOSS
.18      P/AR (for .18 or .18A)
.25A-232 REMOTE CONTROL RS232 REV XYY.YY
.30      IMD & P/AR
.35A     CALL PROGRESS
.35C     CALL PROGRESS
.40      VOM/CAP
.41      MASTER/SLAVE
.52      RESPONDER INTERFACE
.60      DTMF/MF
.62      PCM
.64      ESF PCM
.65      T1 BER REV XYY.YY
.70      EASYTEST INTERPRETER
.71-012  REACT EASYTEST REV XYY.YY
.72      EASYTEST EDITOR/RAM BUFFER
```

Display Serial Interface Transmission Parameters: DEIA

7 DATA	1 STOP	NO PARITY	110
8 DATA	2 STOP	PARITY ODD	thru
		PARITY EVEN	9600

CONTROL COMMANDS (continued)

Display Installed EasyTest Procedure Set:

DIR A or DIR R or DIR H or DIR
 (all) (RAM only) (hidden only) (major)

DIRECTORY OF .71-002 M/S EASYTEST REV A10.03
 PROC SIZE STATUS
 LLFSWP 183 ROM
 thru thru thru
 DMAST 155 ROM
 12129 RAM BYTES FREE

Help Commands:

Display list of commands: HELP

Display list of command parameters: HELP <command>

Master/Slave and Transmission Path Control Commands (Option .41):

Send following commands to Master CTS: <ESC(ASCII 1B)>M<CR>

Send following commands to Slave CTS: <ESC(ASCII 1B)>S<CR>

Set transmission path control character:

SESC AX

(A indicates CTRL and X is ASCII values 40 through 5F except 41-44, 48, 4D, 53)

Display transmission path control character: DESC

AX

A²

Slave Measurement Delay Setup:

SDEL XXSEC

 0SEC²

(delay duration 0≤XX≤99)

Master/Slave Send Level Setup:

SMSL ±XX.XDBM

 OFF³ -16.XDBM²

(send level +10.0≥XX.X≥-70.0) (disable M/S)

CONTROL COMMANDS (continued)

Display Master/Slave Send Level Setup: DMSL

±XX.XDBM OFF

Exit Slave Mode: SEXS

Send commands that follow Master, but continue to pass Slave data:

<ESC>R (ASCII 1B) <CR>

(For use in EasyTest procedure. Cleared by <ESC>S or <ESC>M. Must be preceded by <ESC>S.)

Calendar/Clock Commands:

Calendar Clock Setup:

STIM MMDDYY hh:mm:ss
where 01≤MM≤12 month
01≤DD≤31 day
00≤YY≤99 year
00≤hh≤23 hour
00≤mm≤59 minute
00≤ss≤59 second

Display Time: DTIM

MM/DD/YY hh:mm:ss

RAM Buffer Commands (Option .74):

Enable RAM buffering: SBUF ON

Disable RAM buffering: SBUF OFF

Disable RAM buffering and print stored data: SBUFF OFF DUMP

Print stored data (RAM buffer must be disabled): SBUF DUMP

5.4.2 Line Interface Commands
(Options .35A, .35C, and .60)

LINE INTERFACE COMMANDS

Line Interface Setup Command:

SLIN 135 or 600 or 900 or 1200 135SND or 600SND² or 900SND or 1200SND
 1 6 9 12 1SND 6SND 9SND 12SND
 (send and receive impedance) (send impedance)

135RCV or 600RCV² or 900RCV or 1200RCV BRDG² or TERM, NORM² or REV,
 1RCV 6RCV 9RCV 12RCV B T N R
 (receive impedance) (rcv term) (line reversal)

HOLD^{3, 4} LOOP^{3, 5}
 H L
 (hold) (int loopback)

Display Line Interface Setup Command: DLIN

135SND or 600SND or 900SND or 1200SND 135RCV or 600RCV or 900RCV or
 1200RCV BRDG or TERM NORM or REV HOLD LOOP

Supervision Selection Commands:

Loop-Start Supervision Signaling (w/o Option .35A or .35C)

SLPS²

Display Supervision Status: DSUP

LOOP-START

Loop-Start Supervision Signaling (w/Option .35A or .35C)

SLPS² BATTFEED³ or RBWD³
 (internal battery)

Display Supervision Status: DSUP

LOOP-START IDLE or BUSY or RING BATTFEED BNORM or BREV

Wink Detect Response:

SHORT WINK or WINK or OFFHOOK or NO DETECT

LINE INTERFACE COMMANDS (continued)

Ground-Start Supervision Signaling (w/Option .35A or .35C)

SGSS BATTFEED³ or RINGGND³
 (internal battery) (ground ring terminal)

Display Supervision Status: DSUP

GND-START IDLE or BUSY or RING BATTFEED or RINGGND

Tip Ground Detection: DSUP TIP³

GND or OPEN BATTFEED RINGGND

E&M Signaling (with Option .35A or .35C)

SEMS	THRU ² or SPLT,	LINE REL ²	EQPT REL ²	1
		SEZ	SEZ	2
		SEZWD	SEZWD	3
				4
				5
	(monitor control)	(split mode line/eqpt supervision)		(type)

Wink Detect Response:

SHORT WINK or WINK or OFFHOOK or NO DETECT

Display Supervision Status: DSUP

E&M LINE IDLE or BUSY EQPT IDLE or BUSY THRU or SPLIT

LINE	REL	EQPT	REL	TYPE 1
	SEZ		SEZ	TYPE 2
				TYPE 3
				TYPE 4
				TYPE 5

SF Signaling (w/Option .35C)

SSFS	ON ² or OFF or OFFWD or RING,	H,	±XX.XDBM
	(SF supervision)	(hold SF state outside DIAL/TALK)	(SF send level)

SF Ring Response:

ANSWER or NO ANSWER or OFFHOOK

LINE INTERFACE COMMANDS (continued)

Display Supervision Status: DSUP ALL³ (All for SF ring detect)

SF PRESENT or ABSENT or RING ON or OFF

Wink Detect Response:

SHORT WINK or WINK or OFFHOOK or NO DETECT

No Signaling (4W dry circuit)

SNON

Display Supervision Status: DSUP

NONE

Call Progress Detection Command (w/Option .35A or .35C): DCPG

DIAL TONE or TRUNK BUSY or LINE BUSY or NO TONE

Dial Commands:

Universal Dial Command:

DIAL	XXN,	DPS ⁶ ,	YY...YY	(0-9,+,-) ⁸ or
		DTMF ⁷		(0-9,*,#,A-D,+,-) ⁸
		MF ⁷		(0-9,E,T,K,P,S,+,-) ⁸

01≤XX≤99

(register #)

(addressing type)

(up to 40 digits)

ONHOOK ^{3,8} ,	or	RING ⁹ ,	NORM ² or REV,	HOLD ^{3,4} ,	GEN ³ ,	or	TPT ³ ,
ON			N	R	H		G
O							

(line reversal)

(hold)

(gen)

(IPT detect)

LINE or EQPT,	WINK ³ ,	FXOLS ³ ,	I,	VF ³ ,	SON or SOFF
		FXOGS			
		FXSLS			
		FXSGS			

(E&M dir)

(wink enable)

(FX)

(no idle)

(analog)

(onhook offhook)

LINE INTERFACE COMMANDS (continued)

Display DTMF/MF Send Level Setup: DMFL

±XX.XDBM

Receive Digit Setup Command (w/Option .35C only):

SRTT DPS or DTMF or MF, LINE or EQPT, CLEAR
C
(addressing type) (E&M pulse) (clear digit buffer)

Display Received Digits Command (w/Option .35A or .35C): DRTT

DPS or DTMF or MF XX...XX or NO DIGITS RECEIVED
(40 digits)

Clear Receive Digit Buffer: DRTT CLEAR
C

Automatic Dial Number Entry Command:

SADN	XXN,	DPS,	0-9, +, - ⁸
	01N ²	DTMF ⁷	0-9, *, #, A-D, +, - ⁸
		MF ⁷	0-9, E, T, K, P, S, +, - ⁸
	01≤XX≤99		
	(register #)	(addressing type)	(40 digits)

Display Automatic Dial Numbers Command:

DADN XXN
ALL
(register #)

XXN*¹³ DPS or DTMF⁷ or MF⁷ YY...YY

5.4.3 Test Signal Generator
Commands

TEST SIGNAL GENERATOR COMMANDS

Level/Frequency Setup Command:

SSND QUIET^{2,3} or $\pm XX.XDBM$, XXX.XXXKHZ or TESTTONE or LBT,
 QT -0.0DBM² 1.00KHZ² TT
 (level) (frequency) (2713-Hz loopback)

SKIP³, 1ST
 SK 10ST
 100ST or STEP or S
 1KST
 10KST (Option .10 only)
 (SF Skip) (step size)

Display Level/Frequency Setup Command: DSND

QUIET TERM or $\pm XX.XDBM$ XXX.XXXKHZ or TESTTONE or LBT STEP or 1Hz or
 10Hz or 100Hz or 1kHz or 10kHz SKIP

Sweep Setup Command:

SSWP $\pm XX.XDBM$, XXX.XXLL, XXX.XXHL, STEP³, SKIP³, HI² or MID or LO,
 -0.0DBM² 0.30LL² 3.21HL² S SK H M L
 (level) (low limit) (high limit) (100 Hz) (SF skip) (sweep rate)

UP or DOWN or AUTO²
 U D A
 (sweep direction)

Display Sweep Setup Command: DSWP

$\pm XX.XDBM$ XXX.XXXHZLL XXX.XXKHZHL STEP SKIP HI or MID or LO
 UP or DOWN or AUTO

5.4.4 Level, Frequency, S/N Ratio
Measurement Commands

LEVEL, FREQUENCY, S/N RATIO MEASUREMENT COMMANDS

Level Setup Command:

SLVL	ABS ¹⁴ or $\pm$ XTLP,	SN ³ or DAMP ³ ,	HPF ^{3,5} ,	SET0 ^{3,4}
	$\pm$ 0TLP ²	D	H	
	(TLP set)	(S/N or damping)	(hp filter)	(ref.set)

Display Level Setup Command: DLVL

$\pm$ XXDBTLP	S/N or DAMP	HPF	SET0
---------------	-------------	-----	------

Measure Level Command:

MLVL	3002 or C1 or C2 or C3A or C3T or C4 or C5 or DC
	(conditioning mask)

Measure Level Command Output Format:

$\pm$ XX.XDBM	XXX.XXXKHZ	XXDBS/N or **DBS/N	PASS
DBM0	***.***KHZ	(when S/N out-of-range)	FAIL
DB			

Fast Measure Level Command: MFLV**Fast Measure Level Command Output Format:**

$\pm$ XX.XDBM	XXX.XXXKHZ
DBM0	***.***KHZ

5.4.6 Return Loss Measurement
Commands (Option .16)

RETURN LOSS MEASUREMENT COMMANDS

Return Loss Setup Command:

SRLS	ERL or ERLMSG or SRLLO ² or SRLHI or SINE,	ZERO ³
	SRL	Z
	(test signal)	(zero reference)
4W ² or 2W600 or 2W900 or 2W1200 or 2WEXT,	DAMP,	±XX.XTHL
2W6 2W9 2W12	D	
(4W/2W impedance select)	(damping)	(transhybrid loss)

Display Return Loss Setup Command: DRLS

ERL or ERLMSG or SRLLO or SRLHI or SINE	4W or 2W600 or 2W900 or
2W1200 or 2WEXT	DAMP ±XX.XTHL

Measure Return Loss Command: MRLS**Measure Return Loss Command Output Format:**

±XXDBM	±XXDBRLOSS	(for ERL, SRLLO, SRLHI)
	***DBRLOSS	(for zero reference, not set)
±XXDBM	XXX.XXXKHZ	±XXDBRLOSS (for SINE)

5.4.7 ESF PCM Measurement
Commands (Option .64)

ESF PCM MEASUREMENT COMMANDS

PCM Setup Command:

SPCM	OFF ³ or INLINE ² ,	AMI ² ,	D3D4 ² ,	TANDEM ¹⁶ ,	REMCOM ³ or
	B8ZS		SL96	THRU ²	SREMCOM
			ESF		
			D1D		
			D2		
			AUTO		
	(mode)	(line code)	(chan format)	(alarm mode)	(rem com)
EXT ^{3,16} ,	AB ² ,	DI ³ ,	FRE ² ,	TOE ^{2,20} ,	XXCH,
	ABAB	MON ³	FRW	TOW	01CH ²
	ABCD	PTRN ¹⁷		CONF ¹⁸	01≤XX≤24
	AAAA				
	SF				
	NONE				
(ext int)	(PCM sig)	(DI)	(rcv dir)	(DI dir)	(chan #)
					(PCM term)
					(FDL D&I)
TRML,	AMI ² ,	D3D4 ² ,	0.3S ¹⁹ ,	SLAVE ^{2,19} or	MASTER,
	B8ZS	ESF	2.6S	S	M
		D1D	NOALM ¹⁶		
		D2			
					AB ² ,
					ABAB
					ABCD
					AAAA
					SF
					NONE
					(PCM signaling)
(mode)	(line code)	(frame format)	(alarm delay)	(send clock)	
DI ^{3,19} ,	DTOD ² ,	FRE ² ,	TOE ^{2,20} ,	XXCH,	EAST ¹⁹ ,
IDLE ²	ATOD	FRW	TOW	01CH ²	WEST ¹⁹
LOOP ¹⁶	DTOA		CONF ¹⁸	01≤XX≤24	
AIS ¹⁶					
RALM ¹⁶					
PTRN ¹⁷					
(D&I)	(arrangement)	(rcv dir)	(D&I dir)	(chan #)	(adv mode dir)
REMCOM ³ or	EXT ^{3,16} ,	T ² or			
SREMCOM		B			
(remote com)	(ext int)	(PCM term)			

ESF PCM MEASUREMENT COMMANDS (continued)

DCS,	AMI ²	0.3S,	AB ² ,	DI ³ ,	FRO ² ,	TOO ² ,
	B8ZS,	2.6S	ABAB	MON ²	FRE	TOE
		NOALM ^{2, 16}	ABCD	PTRN ¹⁷		CONF
			AAAA			
			SF			
			NONE			
(mode)	(line code)	(alarm delay)	(PCM sig)	(DI)	(rcv dir)	(DI dir)
	FDL ^{3, 16} ,	XXTP,	REMCOM ³ or EXT ^{3, 16} ,	D3D4,		T ²
		01TP ²	SREMCOM	ESF		B
		01≤XX≤12				
(FDL DI)	(test port #)	(rem com)	(ext int)	(framing format)		(PCM term)

Display PCM Setup Command: DPCM

ON or OFF INLINE or TRML or DCS B8ZS or AMI D3D4 or D1D or D2 or
 ESF or SL96 or AUTO AB or ABAB or ABCD or AAAA or SF or NONE
 FROMEAST or FROMWEST TOEAST or TOWEST or CONF FROMODD or FROMEVEN
 TOODD or TOEVEN or CONF XXCH or XXTP DTOD or ATOD or DTOA
 TANDEM or THRU EXT or REMCOM or SREMCOM T or B FDL EAST: or
 WEST: MASTER or SLAVE 0.3S or 2.6S or NOALM MON or IDLE or DI or
 LOOP or AIS or RALM or PTRN

PCM Signaling Setup Command:

SPCS	AB ² ,	VXYZE or VXE,	VXYZW or VXW,	VXYZO or VXO,	VXYZE or VXE
	ABAB	ONE	ONW	ONO	ONE
	ABCD	OFFE	OFFW	OFFO	OFFE
	AAAA				
	SF				
(PCM sig type)		(inline+term supervision)		(DCS supervision)	

WINK³
 (wink gen)

(V=A bit, X=B bit, Y=C bit, Z=D bit; 0, 1, or X)

ESF PCM MEASUREMENT COMMANDS (continued)

Display PCM Signaling Command: DPCS

INLINE or TRML mode:

AB or ABAB or ABCD or AAAA TO VXYZE or VXE
AB or ABAB or ABCD or AAAA TO VXYZW or VXW
AB or ABAB or ABCD or AAAA FROM ENOPCM or EFRALM or ERFALM or EAIS
VXYZE or VXE
AB or ABAB or ABCD or AAAA FROM WNOPCM or WFRALM or WRFALM or WAIS
VXYZW or VXW

SF TO ONE or OFFE
SF TO ONW or OFFW
SF FROM ENOPCM or EFRALM or ERFALM or EAIS ONE or OFFE
SF FROM WNOPCM or WFRALM or WRFALM or WAIS ONW or OFFW

(V=A bit, X=B bit, Y=C bit, Z=D bit; 0 or 1)

DCS mode:

AB or ABAB or ABCD or AAAA TO VXYZO or VXO
AB or ABAB or ABCD or AAAA TO VXYZE or VXE
AB or ABAB or ABCD or AAAA FROM NOPCM or FRALM or RFALM or AIS
VXYZO or VXO
AB or ABAB or ABCD or AAAA FROM NOPCM or FRALM or RFALM or AIS
VXYZE or VXE

SF TO ONO or OFFO
SF TO ONE or OFFE
SF FROM NOPCM or FRALM or RFALM or AIS ONO or OFFO
SF FROM NOPCM or FRALM or RFALM or AIS ONE or OFFE

(V=A bit, X=B bit, Y=C bit, Z=D bit; 0 or 1)

ESF PCM MEASUREMENT COMMANDS (continued)

Measure PCM Performance Command:

MPCM XXXHR YY.YMIN, RPT, EAST, STOP, MON
WEST
(meas timer) (30 sec repeat) (dir) (terminate test) (monitor test)
(100≥XXX≥0 hours, 59.9≥YY.Y≥0.0 min)

MFE (Multiframe Bit Errors, superframe only)
BPV (Bipolar Violations)
ERS (Errored Seconds)
FBE (Frame Bit Errors)
FRA (Frame Alignment Alarms)
EX0 (Excessive Zeros)
RFA (Remote Frame Alignment Alarms)
NPA (No PCM Alarms)
CRC (CRC Errors, ESF only)
(totalizer)

Measure PCM Performance Command Output Format:

XXX:YY.Y*21 ELAPSED TEST TIME
XXXX EAST BP VIOLATIONS
XXXX EAST ERRORED SECS
XXXX EAST FRAME ERRORS
XXXX EAST FRAME ALARMS
XXXX EAST EXCESS 0'S
XXXX EAST REMOTE ALARMS
XXXX EAST NO PCM ALARMS
XXXX EAST CRC ERRORS (ESF only)
XXXX EAST MFAS ERRORS (superframe only)

IMPULSE NOISE MEASUREMENT COMMANDS

XXXXHI XXXXMD XXXXLO XXXX.XMIN*²¹ NO TONE

5.4.9 Hits and Dropouts Measurement Commands (p/o Option .13)

HITS AND DROPOUTS MEASUREMENT COMMANDS

Hits and Dropouts Setup Command:

SHDO	XXDEG,	XXDB,	BELL ² or FAST,	TEST ^{3, 5, 22}
	5DEG ²	2DB ²	B	F
	(phase hit)	(gain hit)	(count rate)	(test source)

Display Hits and Dropouts Setup Command: DHDO

XXDEG XXDB BELL or FAST TEST

Measure Hits and Dropouts Commands:

MHDO	XXMIN or CONT,	YY.YINT ³	(hits and dropouts)
MIHD	XXMIN or CONT,	YY.YINT ³	(impulse noise, hits, DO)
	(measurement timer)	(print interval)	

Measure Hits and Dropouts Command Output Format:

XXXXPH XXXXGH XXXXD0 XXXX.XMIN*²¹ INV SIG

5.4.10 Envelope Delay Measurement Commands (Option .12)

ENVELOPE DELAY MEASUREMENT COMMANDS

Delay Setup Command:

SDLY MASTER² or SLAVE or SLAVEAMP, RCV² or SEND, ABS¹⁴ or $\pm$ XXTLP
M S SA $\pm$ 0TLP²
(master/slave/slave + amp) (displayed freq) (TLP set)

DAMP³ ZERO^{3, 27} SET0³
D Z
(damping) (delay zero reference) (level zero reference)

Display Delay Setup Command: DDLY

MASTER or SLAVE or SLAVEAMP RCV or SEND $\pm$ XXDBTLP DAMP SET0

Measure Delay Command:

MDLY 3002 or C1 or C2 or C3A or C3T or C4 or C5
(conditioning mask)

Measure Delay Output Command Format:

$\pm$ XX.XDBM	PASS ²³	XXX.XXXKHZ	$\pm$ XXXXUS	PASS
DBM0	FAIL		INV LEVEL	FAIL
DB			INV SIG	FAST

5.4.11 Amplitude Jitter Measurement
Commands (p/o Option .13)

AMPLITUDE JITTER MEASUREMENT COMMANDS

Amplitude Jitter Setup Command:

SAMJ	BELL ² or BLF,	TEST ^{3, 5, 22}
	B	T
	(jitter frequency range)	(self-test)

Display Amplitude Jitter Setup Command: DAMJ

BELL or BELL+LF TEST

Measure Amplitude Jitter Command: MAMJ**Measure Amplitude Jitter Command Output Format:**±XXDBM XXX.XXXKHZ XX.X%PEAK

5.4.12 Phase Jitter Measurement
Commands (p/o Option .13)

PHASE JITTER MEASUREMENT COMMANDS

Phase Jitter Setup Command:

SPHJ BELL² or BLF, TEST^{3, 5, 22}
B T
(jitter frequency range) (self-test)

Display Phase Jitter Setup Command: DPHJ

BELL or BELL+LF TEST

Measure Phase Jitter Command: MPHJ**Measure Phase Jitter Command Output Format:**

±XXDBM XXX.XXXKHZ XX.XDEGP-P

5.4.13 Intermodulation Distortion
Measurement Commands
(Option .14 or p/o .30)

INTERMODULATION DISTORTION MEASUREMENT COMMANDS

Intermodulation Distortion Setup Command:

SIMD SNT^{3, 5} TEST^{3, 5, 24}
T
(send 2 tones) (self-test)

Display Intermodulation Distortion Setup: DIMD

SNTEST or TEST

Measure Intermodulation Distortion Command:

MIND DC²⁵
(D-conditioning)

Measure Intermodulation Distortion Command Output Format:

±XXDBM	XXDB2ND	XXDB3RD	RCV SNTEST	PASS
±XXDBM	SPURIOUS			FAIL
	INV LEVEL			****

5.4.14 P/AR Measurement Commands (Option .18, .18A, or p/o .30)

P/AR MEASUREMENT COMMANDS

P/AR Setup Command:

SPAR	DAMP ³ ,	TEST ^{3, 5, 26}
	D	T
	(damping)	(self-test)

Display P/AR Setup Command: DPAR

DAMP TEST

Measure P/AR Command: MPAR**Measure P/AR Command Output Format:**

±XXDBM XXXP/AR UNITS INV LEVEL

5.4.15 VOM/CAP Measurement Commands (Option .40)

VOM/CAP MEASUREMENT COMMANDS

VOM/CAP Setup Command:

SVMC VDC² or VAC or MADC or MAAC or RES or RESH or CAP or CAPH,
ADC AAC RESL CAPL
(measurement selections)

TR² or TS or RS, NORM² or REV D^{3,28}
N R
(input configuration) (line reversal) (discharge)

Display VOM/CAP Setup Command: DVMC

VDC or VAC or MADC or MAAC or RESL or RESH or CAPL or CAPH,
TR or TS or RS NORM or REV D

Measure VOM/CAP Command: MVMC

Measure VOM/CAP Command Output Format:

±XX.XVDC or ±XXXVDC or ++++VDC or ----VDC
XX.XVAC or XXXVAC or ++++VAC

±XX.XMADC or ±XXXMADC or ++++MADC or ----MADC or OVERLOAD or BAD FUSE
XX.XMAAC or XXXMAAC or ++++MAAC or OVERLOAD or BAD FUSE

0.XXXKOHM or X.XXKOHM or XX.XKOHM or 0.XXXMOHM or X.XXMOHM or
XX.XMOHM or ++++KOHM or ****KOHM

X.XXUFD or XX.XUFD or ++++UFD or ****UFD or BAD FUSE

BAD CAL0
BAD CAL5

5.4.17 T1 Bit Error Ratio
Measurement Commands
(Option .65)**T1 BIT ERROR RATIO MEASUREMENT COMMANDS****T1 Bit Error Ratio Setup Command:**

SBER 2E9 or 511, PRMRY² or CHNNL, B8=1² or CLR, FRMD² or UNFR,
 2E11 or 2047
 2E15
 2E20
 2E23
 QRSS²
 ALL1
 ALT
 3IN24
 XXXXXXH

(pattern) (T1 or channelized rate) (56kbps or 64 kbps) (format)
 (XXXXXXXH is user data pattern of 8, 16, or 24 hex bits)

SLAVE² or MASTER, XE-YBE or XXBE³, XE-YBPV or XXBPV³,
 S M OBE (turns off) OBPV (turns off)
 (X=1, 2, 5; Y=3-9; 1≤XX≤99)
 (send clock source) (bit error injection) (BPV injection)

XE-YFRBE or XXFRBE³, CSUUP³ or SMJUP³ or RDLUP³ or RDL1UP³ or
 OFRBE (turns off) CSUDN³ SMJDN³ RDLDN³ RDL1DN³
 (frame bit error injection)

DS0AOCU³ or DS0ACSU³ or DS0ADSU³ or
 DS0ADN³
 (CSU,SMJ, RDL, or DS0A loopback)

LINE³ or PLD³, or NDEV0³ or NDEV1³ or NDEV2³ XXSEC,
 30SEC²
 (5≤XX≤30)
 (line or payload loopback) (number of repeaters in loop) (loopback timeout)

EWCLK² or EICLK or WICLK, 1HZ² or 0.1HZ,
 (freq diff meas clock direction) (freq diff resolution)

EAST or WEST OFF or ON or THRU
 (send output direction) (send output control)

T1 BIT ERROR RATIO MEASUREMENT COMMANDS (continued)

Display T1 BER Command: DBER

511 or 2047 or 2E15 or 2E20 or 2E23 or QRSS or ALL1 or ALT or 3IN24 or
 XXXXXXH PRMRY or CHNNL B8=1 or CLR FRMD or UNFR SLAVE or MASTER
 XE-YBE XE-YBPV XE-YFRBE 0.1HZ or 1HZ XXSEC EON or EOFF or
 ETHRU WON or WOFF or WTHRU

Measure Bit Error Ratio Command: MBER**Measure Bit Error Ratio Command Output Format:**

0:00.5 ELAPSED TEST TIME
 FREQUENCY DIFFERENCE: 0Hz

	COUNT	RATIO
BIT ERRORS:	0	0.00E-0
BPVs:	0	0.00E-0
FRAME ERRORS:	0	
MFAS ERRORS:	0	
CRC ERRORS:	N/A	
NO PCM ALARMS:	0	
EXCESSIVE ZEROS:	0	
REMOTE ALARMS:	0	
PATTERN SLIPS:	N/A	
FRAMING SYNC LOSSES:	0	0.0SEC
PATTERN SYNC LOSSES:	0	0.0SEC
	ASYNC	SYNC
ERRORED SECONDS:	0	0
SEVERELY ERRORED SECONDS:	0	0
DEGRADED MINUTES:	0	
UNAVAILABLE SECONDS:	0	
ERROR FREE SECONDS:		
	100.000%	100.000%

Measure ESF FDL Performance Command: MFDL

T1 BIT ERROR RATIO MEASUREMENT COMMANDS (continued)**Measure ESF FDL Performance Command Output Format:**

0:12.3 ELAPSED TEST TIME	OVERALL		CURRENT	
ERROR EVENT	EAST	WEST	EAST	WEST
(G1) CRC = 1:	0	0	0	0
(G2) CRC = 2-5:	0	0	0	0
(G3) CRC = 6-10:	0	0	0	0
(G4) CRC = 11-100:	0	0	0	0
(G5) CRC = 101-319:	0	0	0	0
(G6) CRC = >319:	0	0	0	0
(SE) FRAME SYNC:	0	0	0	0
(FE) FRAME BIT:	0	0	0	0
(LV) BPV'S:	0	0	0	0
(SL) SLIP:	0	0	0	0
DISCARDED SECONDS:	0	0		
ERRORED SECONDS:	0	0		
SEVERELY ERRORED SECONDS:	0	0		
UNAVAILABLE SECONDS:	0	0		
ERROR FREE SECONDS:				

100.000% 100.000%

Measure Round-Trip Delay Command: MRTD**Measure Round-Trip Delay Command Output Format:**

XXXXMSEC or ++++MSEC or NO SYNC - NOPCM or NO RESPONSE or
NO SYNC - PATTERN

Display Error Log Contents Command:

DLOG XX
22
(lines per page, 1≤XX≤22)

Display Error Log Contents Command Output Format:

DATE	TIME	INTV	BERR	EVENT
10/24/91	13:40:25	2	3813	BERR, FRBE, SES
10/24/91	13:39:03	1	36	BERR, FRMSYNC

PRESS "Q" TO ABORT, ANY OTHER KEY TO CONTINUE or NO EVENTS LOGGED

Display the Number of Stored 15 Minute Intervals Command: DINT**Display the number of Stored 15 Minute Intervals Command Output Format:**

XXX
(0≤XXX≤400)

T1 BIT ERROR RATIO MEASUREMENT COMMANDS (continued)

Display Stored 15 Minute Interval Test Results Command:

DIND XXXSTART, YYYSTOP
 (start at interval XXX) (stop at interval YYY)
 (1≤XXX≤400; no entry, XXX=1) (1≤YYY≤400; no entry, last interval)

Display Stored 15 Minute Interval Test Results Command Output Format:

INTV	DATE	TIME	PSYNC	ERRSEC	SES	UNAVS	DEGMIN	BERR	BPV	FRBE
1	10/24/91	13:39:32	3	2	2	0	0	72	74	36
2	10/24/91	13:54:32	3	5	3	0	0	++++	68	220

or NO INTERVALS STORED

FOOTNOTES FOR COMMAND DESCRIPTIONS.

- 1 if PCM is on and in DCS mode when SCLR W occurs, PCM stays on in DCS mode; all other parameters are cleared
- 2 default parameter value at power up
- 3 "momentarily" omitting turns function off
- 4 not valid in E&M signaling or NONE
- 5 SGTL turns function off
- 6 not valid in NONE
- 7 Option .60 required
- 8 entering a - causes a one-second delay; a + causes a wink detection with Option .35A or .35C
- 9 only use for FX office sequences
- 10 entering a - causes a one-second delay
- 11 before receiving incoming ring, an ONHOOK command must be sent to avoid permanent damage
- 12 DTMF/MF defaults to the current send level until the first SMFL command is received
- 13 currently selected automatic dial number register is indicated by *
- 14 if ABS is true, then TLP=0 dBm up
- 15 Option .15, .15B, or .15C Noise Filters required
- 16 advanced mode parameter
- 17 available only when Option .65 T1 BER is installed. Activates the Option .65.
- 18 remote communication mode only
- 19 independently set for east and west; causes adv mode
- 20 this parameter not available in advanced mode
- 21 timer is active if "*" is present
- 22 self-test for readings of PJ 21.4 ± 1.3 , AJ $18.6 \pm 1.1\%$
- 23 attenuation distortion conditioning printed only if SET0 and DDLY RCV are true
- 24 self-test for reading of 35-dB 2nd and -35 dB 3rd order products with Revision 12 or later firmware
- 25 "DC" refers to D-conditioning; only valid when S/N is true
- 26 self-test for reading of 59 P/AR units with Revision 12 or later firmware
- 27 ensure that the delay modules have been active, with the forward and return signals applied at both ends

- for a minimum of five seconds before sending a delay zero reference command
- 28 With "D" parameter included, input configuration selected is shunted with 1Ω for 64 ms before a resistance or voltage measurement is made.

5.4.18 EasyTest Procedure Commands

A CTS equipped with Option .25A includes a basic REACT set of EasyTest procedures, Option .71-012. EasyTest procedures are programmed routines that enable you to perform complex test procedures by entering one command. Additional procedures can be added by ordering Option .71-002 Master/Slave EasyTest or Option .71-007 Enhanced Master/Slave EasyTest. Also included as a standard feature is Option .72, EasyTest Editor. This option enables you to create, test, and modify EasyTest procedures. (For additional information on EasyTest routines, refer to the EasyTest Editor User's Manual, PN 3772-02, included as a supplement to this manual.)

The following are provided in the paragraphs that follow:

- An example of an EasyTest procedure
- A reference list of REACT, optional Master/Slave, and Enhanced Master/Slave EasyTest procedures
- Definitions of REACT, optional Master/Slave, and Enhanced Master/Slave EasyTest procedures.

5.4.18.1 EasyTest Procedure Example

An EasyTest procedure is a programmed routine made up of procedural language commands. The entire routine is performed by entering one command. For example, EasyTest procedure SEQ2 performs the following tests in response to the command PROC SEQ2:

- Impulse Noise
- Hits
- Phase Jitter
- C-Notch Noise
- Level/Frequency

The procedure performs the tests for a specified period of time and reports results during the measurement. The CTS must be receiving a 1-kHz test tone for this test. The procedural language commands that make up the SEQ2 procedure are listed in Figure 5-3. Figure 5-3 also shows a sample result of the SEQ2 procedure.

SAMPLE PROC LISTING OF SEQ2 (SEQUENCE 2)

```

->LIST SEQ2
PROC SEQ2
SLVL
WAIT F .99LL 1.03HL T=5SEC
IF TIMEOUT
MSG INVALID SIGNAL
EXIT
ENDIF
MIHD *P1MIN *P2INT
SNSE PN
MPHJ
MNSE
MLVL
END
->

```

Operator uses LIST command to examine the contents of PROC SEQ2.

5-second wait for presence of 1-kHz test tone.

P1 and P2 are variable labels for the input parameters of measurement timer and print interval for the measure impulse noise, phase hits, gain hits and dropouts command.

Measurements of phase jitter, C-Notch noise, and level/frequency.

EXAMPLE OF THE OUTPUT OF PROC SEQ2
PROVIDING MEASUREMENTS ON A CHANNEL WITH TEST TONE

```

->PROC SET ^-10;1.0

->PROC SEQ2 ^2;1
    OHI    OMD    OLO    1.0MIN*
    OPH    OGH    ODO    1.0MIN*
    OHI    OMD    OLO    2.0MIN
    OPH    OGH    ODO    2.0MIN
-10DBM 1.004KHZ 0.1DEGP-P
-79.6DBM
-10.0DBM 1.004KHZ
->

```

Operator uses PROC SET to set the send level to -10 dBm, the frequency to 1.0 kHz, and to terminate the receive side. The " ^ " character defines the parameter inputs which are separated by semicolons and in this instance are level and frequency values.

Operator invokes PROC SEQ2 which performs a measurement of impulse noise, phase hits, gain hits and dropouts, phase jitter, a C-Notch noise measurement, and a level/frequency measurement.

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Figure 5-3. EasyTest Procedure SEQ2 Listing and Sample Results

5.4.18.2 EasyTest Procedure List

Table 5-4 provides a list of REACT, optional Master/Slave, and Enhanced Master/Slave EasyTest procedures. For definitions of each procedure, refer to the following paragraphs. To display the list of EasyTest procedures installed, use the command DIR; the set number and firmware revision level, the directory, and the available RAM buffer size in bytes displays.

NOTE: A variety of other procedures are provided in the .71-012 set which include: subroutines, special AUTOREACT procedures, and special REACT procedures. These procedures are not included in the following descriptions due to their limited application.

Table 5-4. EasyTest Procedures List

.71-012 REACT EASYTEST PROC SET	.71-002 MASTER/SLAVE EASYTEST PROC SET	.71-007 ENHANCED EASYTEST PROC SET
829	DMAST	ALL
BK	MADD	MAST3TS
LOOPBK	SET	MASTIHD
MWQ	SETM	MASTIMD
SEQ2		MASTNSE
SETT326		MASTPAR
T125		MASTPHJ
T326		MSAD
TSET		SET
		SETM

5.4.18.3 EasyTest Procedure Descriptions

The following descriptions are listed alphabetically by procedure name. Parameters and examples are provided as necessary.

829: This procedure enables an 829-type loopback device by sending a 2.7-kHz tone for a user-specified number of seconds. The procedure then sends a 1.0-kHz tone and measures the level of the looped signal.

Parameters: P1) Send level
P2) Not used
P3) Response wait

Example: PROC 829 A-10;;3 sends all signals at -10 dBm and waits three seconds after sending the 2.7-kHz tone before switching and taking the 1.0-kHz tone and makes the looped measurement.

ALL: This procedure executes the amplitude and delay sweeps, noise, intermodulation distortion, 3-tone slope, phase jitter, and P/AR tests in sequence.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration
P4) Slave line configuration

Parameters 3 and 4 contain the configuration information (2-wire/4-wire). If a test is invoked and parameters 3 and 4 have never been set, the EasyTest sets either unset parameter to 4-wire. The default to 4-wire makes the changes from previous versions transparent to a former user. The following configurations may be specified:

- 2: 2-wire using Model 3700's 2-wire jack (send jack)
- 4: normal 4-wire operation
- 12: 2-wire using the receive jack
- 14: 4-wire connected to a 2-wire unit

It is recommended (particularly with "Slave" units) that any 2-wire installation be made in the receive jack so a power hit does not render a "Slave" incapable of receiving commands.

BK: This procedure performs the loopback test sequence as in the EasyTest LOOPBK, but omits the P/AR measurement.

Parameters: None required

DMAST: This procedure sequences the master/slave operation of the CTSs through the D-conditioning tests. It then evaluates the measurements to determine if the line passes or fails in both directions.

Parameters: None required

LOOPBK: This procedure performs the loopback test sequence of level, C-notch noise, and P/AR measurement.

Parameters: None required

MADD: This procedure gives a common entry point for all types of C-conditioning sweeps. It allows the user to select either attenuation, delay, or both distortion measurements.

Parameters: P1) Sweeps to perform (A = attenuation, D = delay, AD = both)
P2) C-conditioning mask for CTS (3002, C1, C2, C3A, C3T, C4, C5)
P3) Slave end stabilization time

Example: PROC MADD AD;C2;3 performs a delay distortion sweep in both directions, applying the C2 conditioning mask and allowing the line under test to stabilize for three seconds before a measurement is taken.

MAST3TS: This procedure executes the Master/Slave controlled 3-tone slope test sequence included in the enhanced EasyTest.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MASTIHD: This procedure executes the enhanced EasyTest impulse noise, hits, and dropouts tests.

Parameters: P1) Test duration (minutes)
P2) SIMP command parameters
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

Example: PROC MASTIHD A2; 6S 70LTH; 2; 2 invokes the Master/Slave impulse noise, hits, and dropouts test for a duration of two minutes using a 6 dB spread and 70 dBmC low threshold. The line under test is 2-wire, wired into the send jack.

NOTE: The Slave must have the line reversed prior to invoking this procedure. It must be able to receive its first command.

MASTIMD: This procedure executes the enhanced EasyTest intermodulation distortion test at the master end.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MASTNSE: This procedure executes the enhanced EasyTest C-Notch and C-Message noise tests at the master end.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MASTPAR: This procedure executes the master P/AR test sequence.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MASTPHJ: This procedure executes the phase jitter test sequence.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MSAD: This procedure executes the amplitude and delay sweeps. If either end of the test is 2-wire, only amplitude displays. The frequencies swept are 300 Hz, 400 Hz, 500 Hz, and 600 through 3200 Hz in 200-Hz steps. These sweeps form part of the enhanced EasyTest set.

Parameters: P1) Not used
P2) Not used
P3) Master line configuration (2, 4, 12, or 14)
P4) Slave line configuration (2, 4, 12, or 14)

MWQ: This EasyTest performs measurements against the received milliwatt or quiet termination. The tests performed are selected to execute against the proper device.

Parameters: P1) 0 = device alternates between milliwatt and quiet, to measure level, C-Message noise, and return loss.
1 = device is a milliwatt, so measures level only
2 = device is a quiet termination, so measures C-Message noise and return loss
P2) Send level, if P1 = 0 or 2

SEQ2: This procedure performs the same tests as SEQ1, but only performs the sequence once. The test performs for a user-specified time period (in minutes) and reports results during the measurement.

Parameters: P1) Length of the integrating measurement in minutes
P2) Update interval

Example: PROC SEQ2 A2; .1 performs the integrating measure for 2 minutes reporting current counts every 0.1 minute. It then performs the other three tests.

SET (.71-002): This EasyTest procedure sets some common measurement conditions within the CTS.

Parameters: P1) Send level
P2) Send frequency
P3) Line configuration

SET (.71-007): This EasyTest procedure sets some common measurement conditions within the CTS. This version has been enhanced to support the 2-wire/4-wire mixtures available in the Enhanced EasyTest set.

Parameters: P1) Send level
P2) Send frequency

SETM (.71-002): This EasyTest procedure sets some common measurement conditions within both the master and slave CTSs. It requires Option .41 Master/Slave.

Parameters: P1) Send level
P2) Send frequency

SETM (.71-007): This procedure is used to configure the master and slave CTSs prior to the start of testing. It requires Option .41 Master/Slave.

Parameters: P1) Send level
P2) Send frequency
P3) Master line configuration
P4) Slave line configuration

Example: PROC SETM 10; 1.0 sets both units to send 1.0 kHz at 10 dBm. Both ends terminate, and if P3 and P4 are not previously specified, that parameter is conserved.

SETT326: This procedure sets the CTS for the Wilcom 326 Responder sequence. This must be done due to the tight timing at the start of the EasyTest T326.

Parameters: P1) Send level
P2) Line configuration (see TSET)
P3) H if hold needed

T125: This EasyTest procedure performs the control and measurement sequence with a Hekimian Model 125 Transponder (TR).

Parameters: P1) Send level
P2) 2 = 2-wire, 4 = 4-wire, or 12 = 2-wire reversed

T326: This procedure runs against a Wilcom 326 Responder which uses a fixed sequence test. This procedure requires the use of SETT326 prior to each use to initialize the CTS. The times are DIP switch selectable at the responder. This procedure is designed to meet the following sequence timing:

SEND REF LEVEL	5 T-units	8.5 seconds
MEASURE LEVEL	4 T-units	6.8 seconds
SEND LEVEL RESPONSE	4 T-units	6.8 seconds
MEASURE CN NOISE	5 T-units	8.5 seconds
SEND NOISE RESPONSE	4 T-units	6.8 seconds
SEND QUIET (ERL)	5 T-units	8.5 seconds

T-units range from 0.2 through 1.7 seconds.

Parameters: P1) Send level
P2) 2-wire/4-wire selection (see TSET)

TSET: This EasyTest procedure presets the CTS prior to the start of the Hekimian Model 125 Transponder test. The parameters set are 1-kHz send frequency, a specified level, the C-Notch noise filter, and the count value (used to store 2-wire/4-wire selection).

Parameters: P1) Send level
P2) 2 = 2-wire, 4 = 4-wire, or 12 = 2-wire reversed

5.5 Error Messages

The Option .25A-232 uses error messages to indicate various problems in the operation of the test set. Each error message is labeled with a number to speed recognition in automated systems. The error messages for the Option .25A-232 and their descriptions are presented in the maintenance section.

5.6 Remote Communication Mode

When equipped with Option .25A Remote Control, the CTS can use the VF interface to permit monitor and talk on a channel of the PCM stream via a 2W dial-up line. (Refer to Figure 5-4.) This mode is valuable when performing remote-control troubleshooting from a central test position.

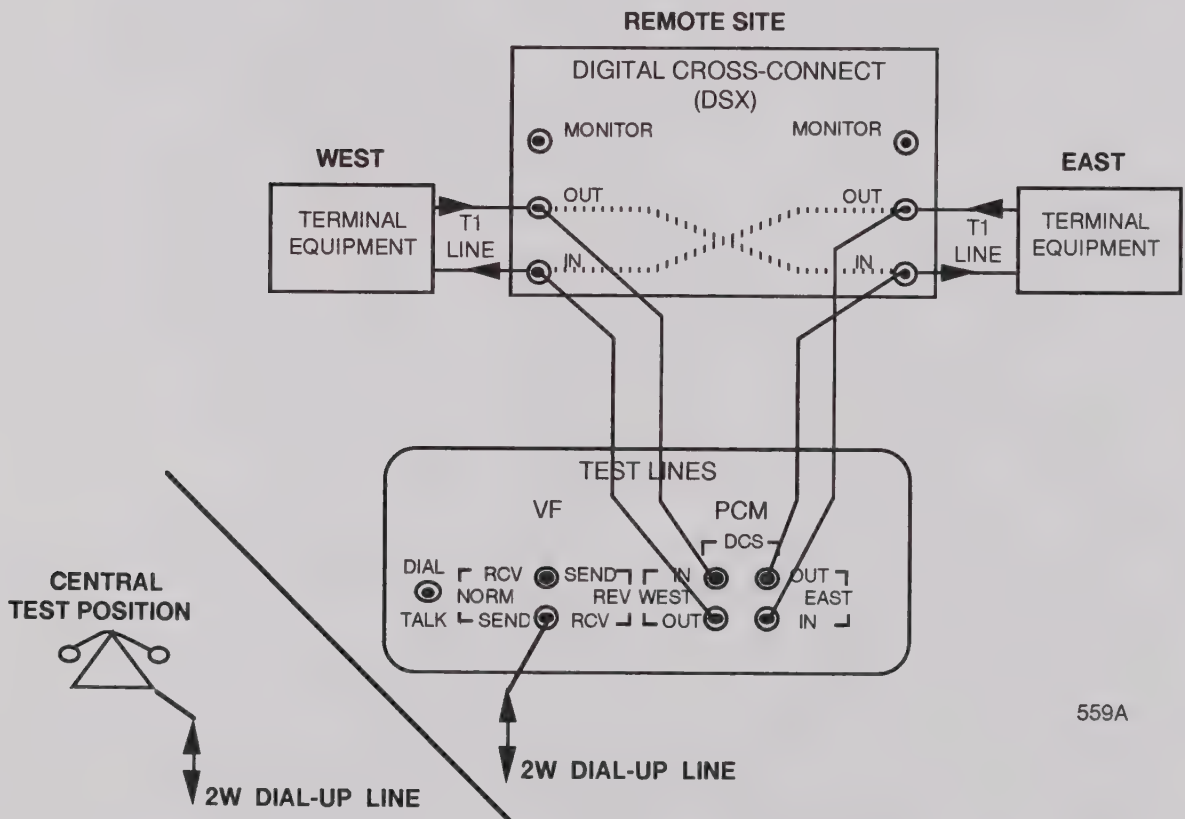


Figure 5-4. Remote Communication Inline Connection Example

5.6.1 Remote Communication Connection

The connections to the PCM line interface are made as described in the front-panel controlled operation section of this manual. The 2W dial-up line is connected to the CTS VF NORM-SEND (2W) jack.

CAUTION: Application of incoming ring voltage to the CTS VF TEST LINES jacks may cause permanent damage to the test set. Both the VF NORM-RCV and DIAL/TALK jacks should be empty. Do not allow incoming ring to be applied to the SEND jack unless Dial/Talk is active and on-hook has been selected.

When the 2W dial-up line is connected to the SEND jack and is not being used for remote communication, it must be kept in the on-hook state using the following commands:

SPCM REMCOM
DIAL VF ON

NOTE: The REMCOM parameter is momentary and must be appended to all SPCM commands or it becomes disabled. If REMCOM is omitted, the remote communication with the VF access is disabled, but the VF line is not dropped. Another SPCM REMCOM command reestablishes remote communication.

5.6.2 Remote Communication Commands

The remote communication mode is comprised of the four functions listed below:

- 1) Dial on the VF NORM-SEND (2W) jack with PCM active.
- 2) Listen to the selected PCM channel from either direction separately or from both directions simultaneously.
- 3) Listen during drop-and-insert.
 - a) Listen to the selected PCM channel from either direction separately or from both directions simultaneously.
 - b) Listen to the VF signal being encoded onto the PCM channel from the CTS generator.

- 4) Dial, talk, and listen on the selected PCM channel.
 - a) Dial to either direction.
 - b) Talk and listen to either direction separately or to both directions simultaneously.

The remote-control commands used to implement each one of these functions are listed in Table 5-5.

NOTE: During operation with the REMCOM parameter, receive SF tones (2600 Hz) are notched out and translated to 2800 Hz. This prevents the 2600 Hz in the PCM channel from dropping the 2W dial-up line if the path contains an SF trunk. During operation with the SREMCOM parameter, the basic unit send side is applied directly to the dial-up line. If the basic unit generator is set near 2600 Hz and not quiet termination, the dial-up line may drop. The SF tones generated by the Option .62 PCM or .64 ESF PCM to control the PCM channel signaling do not appear on the 2W dial-up line during REMCOM or SREMCOM.

Table 5-5. Remote-Control Commands

COMMAND	PARAMETER	ACTION
DIAL	VF	If PCM and REMCOM are active, this parameter directs dialing to the VF NORM-SEND (2W) jack. If this parameter is omitted, dialing occurs on the selected PCM channel.
SPCM	REMCOM	Configures the CTS for remote communication mode. This is a momentary parameter and must be included in each SPCM command to remain active.
SPCM	SREMCOM	Configures the CTS to send (on the 2W dial-up line) the VF signal being encoded on the selected PCM channel when drop-and-insert (DI) is also active.
SPCM	TOE TOW CONF	Selects the direction for talk, listen, and drop-and-insert. If CONF is chosen, then listen from both directions in MON, and talk and listen from both directions in drop-and-insert.
SPCM	FRE FRW	Selects the direction to listen from, unless CONF was chosen above in the direction selection. This parameter overrides the default set by the TO parameter.

5.6.3 Remote Communication
Example

Using the connection shown in Figure 5-4, a typical remote communication would occur as follows:

- 1) Activate the remote communication mode, and protect the SEND jack.

```
SPCM  REMCOM
DIAL  VF  ON
```

- 2) Set up the CTS to access the PCM channel in the inline mode.

```
SPCM  INLINE  MON  XXCH  REMCOM
```

- 3) Dial the central test position from the VF NORM-SEND (2W) jack.

```
DIAL  VF  XXXXXXXX  HOLD
```

- 4) Check the supervision status for idle on the PCM channel; listen on channel.

```
DPCS  (displays A and B bit status)
```

- 5) If the channel is idle, seize the circuit and dial in one direction as follows:

- a) Set the desired A and B bits in both directions.
- b) Activate drop-and-insert to the chosen direction.
- c) Dial the distant end in that direction.

```
SPCS  AB  01E  11W
SPCM  DI  TOW  REMCOM
DIAL  XXXXXXXX  HOLD (PCM dial)
```

- 6) Listen for distant end party to answer, then talk. If you wish to test in that direction, activate the desired test after setting the generator send level.

```
SSND  -13DBM  1.5KHZ
MLVL
```

- 7) To hear the tone being encoded onto the PCM channel:

```
SPCM  DI  SRECOM
```

- 8) To dial in the other direction, once again set up the desired A and B bits and dial:

```
SPCS  AB  11E  11W
SPCM  DI   TOE  REMCOM
DIAL  XXXXXX  HOLD  (PCM dial)
```

- 9) Listen for the distant end party to answer, then talk. To talk and listen to both parties simultaneously, activate conference.

```
SPCM  DI   CONF  REMCOM
DIAL  VF   HOLD  (again enters dial/talk mode)
```

- 10) When the testing is complete, the 2W dial-up line may be dropped and the channel restored.

```
DIAL  VF   ON    (drops the 2W VF interface)
SPCM  MON  REMCOM
```


SECTION 6 - MAINTENANCE

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6.1 Maintenance Guidelines

Maintenance for the Model 3701 VF and Model 3705 PCM/VF Communications Test Systems (CTSs) consist of corrective repairs. No periodic maintenance is required. Corrective repairs are made through replacement of failed modules and PC boards. Replacement procedures and instructions for returning failed equipment for repair are provided in this section.

6.2 Corrective Maintenance Procedures

6.2.1 Fuse Replacement

WARNING

To avoid electrical shock, disconnect primary power before replacing CTS fuse. Replace only with fuse of the specified voltage and current ratings.

The primary power input fuse is located on the right side of the CTS rear panel. The fuse rating requirement is listed on the information plate next to the fuse holder.

6.2.2 Error Message Troubleshooting

The CTS generates error messages indicating either of the following:

- Incorrect operation of CTS by user (remote-control operation only)
- A CTS hardware problem.

The content and format of error messages depend on whether the unit is operating through front-panel controls or remote-control commands. The following paragraphs describe the error messages for each operating mode.

6.2.2.1 Error Messages During Front-Panel Control Operation

During front-panel control operation, hardware problem error messages appear on the alphanumeric display in the following format:

E<XXYY> (example: E<1030>)

The characters within the brackets represent error *codes*. Table 6-1 provides information based on the XX portion of the error code. Tables 6-2 and 6-3 provide additional information based on the YY portion of the code.

Table 6-1. CTS Local Error Code Descriptions

XX HEX	DESCRIPTION
00	RAM failure at YY hex ¹
01	EPROM missing at YY hex ¹
02	EPROM located incorrectly at YY hex
03	EPROM checksum error at YY hex
04	EPROM with wrong revision number at YY hex
05	EPROM with wrong revision letter at YY hex
10	Transducer failure at YY hex ²
21	Background EPROM checksum error at YY hex ¹
22	Loss of foreground activity
30	Illegal RST YY
31 ³	Illegal function, key value YY
32 ³	Illegal external generator, select YY
33 ³	Illegal remote command, command YY
35	DSP generator communications failure
36	T1 BER command communications failure
37	T1 BER data communications failure

¹ See Tables 6-2 and 6-3.
² See Table 6-3.
³ These codes refer to illegal software conditions detected during execution; they do not relate to any particular board other than the Memory/CPU board (3701-2004-02, SMTE60FHAA).

Table 6-2. CTS RAM and EPROM IC Locations on Memory/CPU Assembly

MEMORY	YY HEX	RAM / EPROM IC LOCATION
6264	C0-CF	RAM IC 9
27256	00-7F	EPROM IC 8
	80-BF, E0-FF	EPROM IC 7
27512	00-BF, E0-FF	EPROM IC 7

Table 6-3. CTS Transducer Functions and Addresses

YY HEX	FUNCTION	ASSEMBLY #	CLEI #
10-1F	Alphanumeric Display	3701-0-3-7	
20-2F	Keyboard LEDs	3701-2016-01	
30-3F	4Z I/O	3705-2025-01 (20 kHz) 3705-2025-02 (120 kHz)	SMTE60EHAA SMTE60JHAA
40-4F	Level Meter	3701-2040-01 (20 kHz) 3701-2040-02 (120 kHz)	SMTE60BHAA SMTE60GHAA
50-5F	Frequency Counter	3701-2047-01 (20 kHz) 3701-2047-02 (120 kHz)	SMTE60CHAA SMTE60HHAA
60-6F	DSP Generator	3701-2026-01	SMTE60DHAA
70-71	Hits/Jitter Option	3713-01	TETMEH36AA
78-7F	Noise Filters Option	3715-01 3715B-01 3715C-01	TETMEX26AA TETMEY26AA SMTE60MHAA
90-9F	Envelope Delay Option	3712A-01	SMTE60LHAA
A0-A1	IMD Option	3714-01	TETMEJ36AA
A2	IMD and P/AR Option	3730-01	TEPQ571AAA
A8-AF	Call Progress Option	3735A-01 3735C-01	TETN5506AA TETMEC36AA
B0-B3	P/AR and RLOSS Option	3716-01 3718A-01 (3718-01)	TETMEE16AA (TETM7006AA)
B4	Responder Interface Option	3752-01	
B8-BB	T1 Bit Error Ratio Option	3765-01	TEPQ569AAA
C0-C3	VOM/CAP Option	3740-01	TETNKR06AA
D0-DF	ESF PCM Option	3764-02	SMIUI001AA
F0	Master/Slave Option	3741-01	TETMET26AA
F1-F4	X-Y Outputs	3700-10	

6.2.2.2 Error Messages During Remote-Control Operation

During remote-control operation, error messages display at the control device in the following format:

ENN AAA AAAA (example: E14 RAM FAIL)

Error codes may also appear as shown in the following message:

E05 MOD FAIL XXYX (XXYY is the error code)

Refer to Table 6-4 for descriptions of error messages displayed during remote-control operation. Refer to Tables 6-1, 6-2, and 6-3 for additional information about error codes.

Table 6-4. CTS Remote Error Message Descriptions

MESSAGE	DESCRIPTION
E01 INV CMND	Invalid command; command input syntax error.
E02 INV PARA	Invalid parameter; parameter entry or syntax error.
E03 INV PROC	Invalid procedure; command inhibited; eg., trying to change a line interface parameter during an integrating measurement.
E04 COM FAIL	Interprocessor communications failure.
E05 MOD FAIL XXYX	Module fails to respond on module bus; module may be a basic unit board or option (see Tables 6-1, 6-2, and 6-3).
E06 MOD ABST	Module absent; attempt to access a missing option.
E07 CON PARA	Conflicting parameter; two parameters on the same command line conflict.
E08 INP OVER	Input overrun; entered a command more than 80 characters long.
E10 SLV MODE	CTS in slave mode under control of distant-end master; CTRL-A overrides mode and restores local control.
E11 INC SOFT	Basic unit and remote-control firmware types or revision levels incompatible.
E12 MPL PROM	EPROM installed in wrong socket.
E13 MIS SOFT	Mismatched EPROMs in Option .25A.
E14 RAM FAIL	Defective RAM detected on Option .25A during self-test.
E15 BAD CSUM	Defective EPROM detected on Option .25A during self-test.

6.3 CTS PC Board Replacement Procedures

This section contains procedures for replacing various PC boards installed in the CTS. Figure 6-1 shows the locations of screws securing the top cover of the unit. Figure 6-2 shows the locations of PC boards within the unit. Figure 6-3 shows the location of long board extraction notches used to gently raise PC boards from their edge connector seating.

Step	Removing CTS Top Cover
CAUTION: Hazardous voltages may exist inside the instrument. To help avoid electrical shock, turn POWER switch off and disconnect primary power before proceeding.	
1	To remove the top cover from the CTS, remove screws from the sides and top of the unit. (See Figure 6-1.) Set these screws aside for later assembly.
2	Slide the cover to the rear, and remove it from the unit.
3	To reassemble, slide the cover on towards the front and install screws set aside earlier.

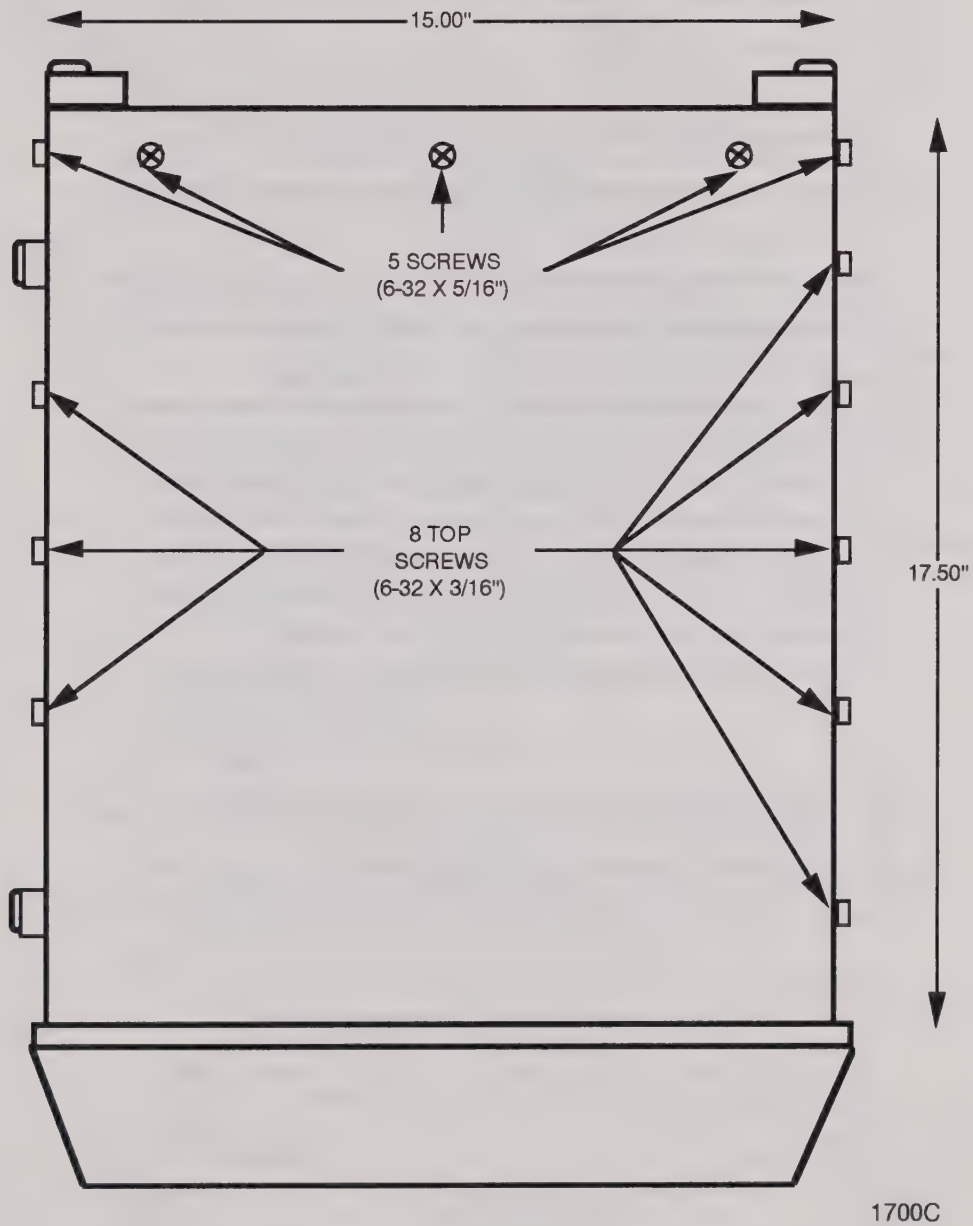
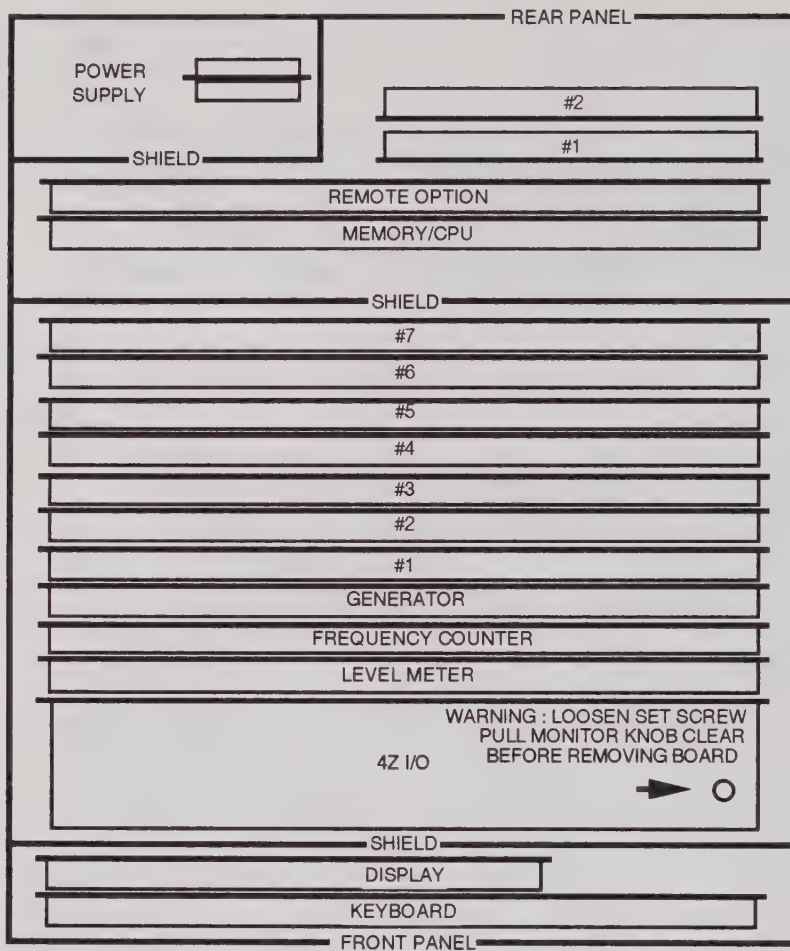
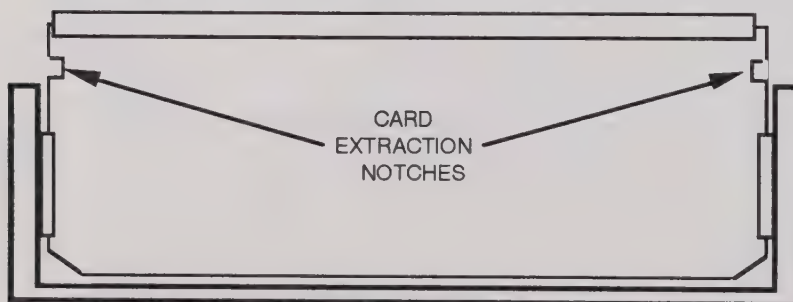


Figure 6-1. CTS Top Cover Attachment Screw Locations



1699A

Figure 6-2. CTS PC Board Locations



1971

Figure 6-3. Long Board Extraction

6.3.1 Memory/CPU Board Replacement

To replace the Memory/CPU board (3701-2004-02, Firmware 3705 D/F18.00, SMTE60FHAA), proceed as follows:

Step	Replacing Memory/CPU Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	If Option .64 is installed, unplug cables to connectors J4W and J4E on the ESF PCM board. These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.
2	Using a flat screwdriver, gently pry up on extraction notches on the sides of the Memory/CPU board. Raise the board until connected cables are exposed.
3	Carefully unplug cables at connectors J9 and J10 on the Memory/CPU board.
4	Remove the Memory/CPU board from the CTS.
5	Align the replacement board in the Memory/CPU board slot but do not seat the edge connector.
6	Connect cables to connectors J9 and J10 on the replacement board.
7	Firmly seat the replacement board in the CTS.
8	Connect cables to connectors J4W and J4E on the ESF PCM board.

6.3.2 4Z I/O Board Replacement

To replace the 4Z I/O board (3705-2025-01 or 3705-2025-02, SMTE60EHAA or SMTE60JHAA), proceed as follows:

Step	Replacing 4Z I/O Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	Using a 0.05-inch hex wrench, loosen the rear set screw securing the MONITOR knob to the potentiometer on the 4Z I/O board. (See Figure 6-2.)
2	Gently slide the MONITOR knob out so that it does not interfere with removal of the 4Z I/O board.
3	Using a flat screwdriver, gently pry up on extraction notches on the sides of the 4Z I/O board.
4	If Option .40 VOM/CAP is installed, unplug the cable at connector J20 on the 4Z I/O board. This cable is part of the VOM/CAP board.
5	Carefully remove the 4Z I/O board.
6	Unplug the cable at connector J19 on the 4Z I/O board.
7	Plug cables to connectors J19 and J20 on the replacement board.
8	Gently slide the replacement board into the 4Z I/O board slot until the edge connector firmly seats.
9	Secure the MONITOR knob to the 4Z I/O board, taking care not to over tighten the set screw.

6.3.3 Remote-Control (Option .25A) Board Replacement

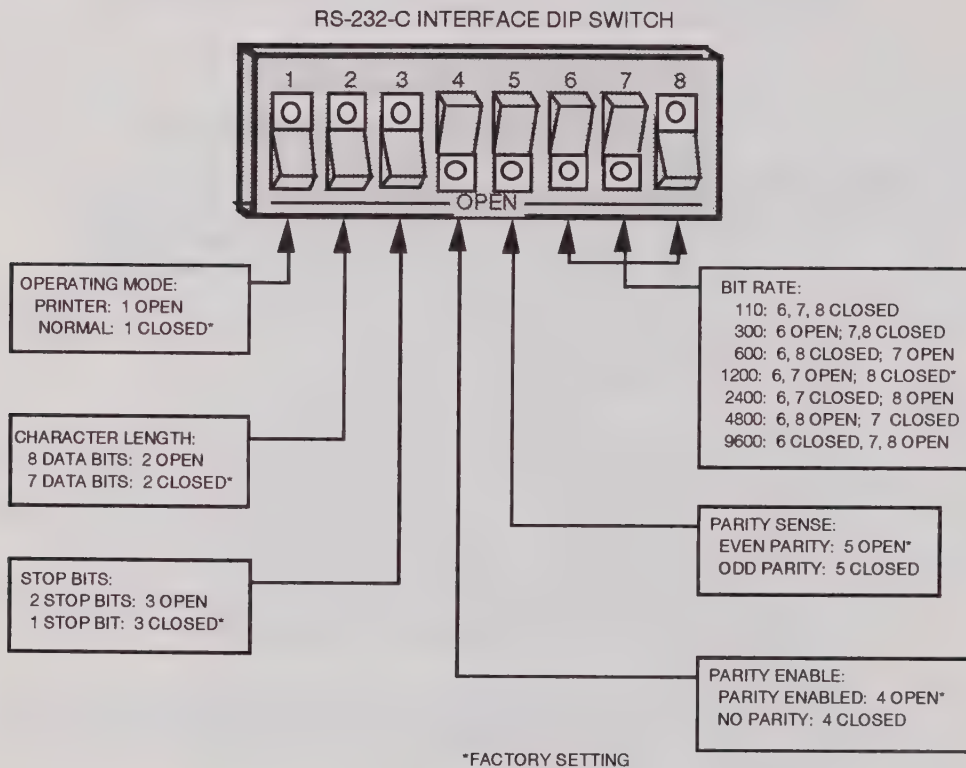
To replace the Remote-Control board (3725A-2006-01, Firmware 3725A A18.00, SMIUED01AA), proceed as follows:

Step	Replacing Remote-Control Option Board
------	---------------------------------------

CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.

- | | |
|---|--|
| 1 | If Option .64 is installed, unplug cables to connectors J4W and J4E on the ESF PCM board. These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel. |
| 2 | Carefully unplug the cable from connector J11 on the Remote-Control board. This cable connects to connector J10 on the Memory/CPU board. |
| 3 | If Option .41 Master/Slave is present, unplug the cable to Remote-Control board connector J23. This cable is part of the Master/Slave board. |
| 4 | Unplug the cable from connector J12 on the Remote-Control board. This cable is part of the RS-232-C Interface connector and DIP switch on the CTS rear panel. |
| 5 | Using a flat screwdriver, gently pry up on the extraction notches on the sides of the Remote-Control board and lift the board from its rear seating connector. |
| 6 | Carefully remove the Remote-Control board. |
| 7 | Gently slide the replacement board into the Remote-Control board option slot until the edge connector firmly seats. |
| 8 | Connect cables to connectors J12, J23, and J11 on the replacement Remote-Control board. |
| 9 | Connect cables to connectors J4W and J4E on the ESF PCM board. |
-

Data transmission parameters are set through the RS-232 INTERFACE DIP switch on the rear of the CTS. Check DIP switch settings against settings shown in Figure 6-4. Correct the switch settings as necessary.



1703B

Figure 6-4. CTS RS-232-C DIP Switch Settings

6.3.4 VOM/CAP Board (Option .40) Replacement

The current overload condition opens the internal current shunt to protect the instrument, and can be reset only by going to the setup mode and then back to the measurement mode. When a large overload results in a blown fuse, the current and capacitance measurement displays show BAD FUSE in the normal digits display. The internal fuse, Bussman GMT type 1-1/3A (white tab), located on the top edge of the Option .40 printed circuit board, must then be replaced.

CAUTION: Replace only with fuse of the specified type, voltage, and current ratings.

To replace the VOM/CAP board (3740-01, TETNKR06AA), proceed as follows:

Step	Replacing VOM/CAP Option Board
------	--------------------------------

CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.

- | | |
|---|--|
| 1 | Using a flat screwdriver, gently pry up on extraction notches on the sides of the VOM/CAP board. Raise the VOM/CAP board until the connected cable to the 4Z I/O board is exposed. |
| 2 | Unplug the cable at J20 on the left side of the 4Z I/O board, <i>not</i> from P20 on the VOM/CAP board. |
| 3 | Remove the VOM/CAP board and cable. |
| 4 | Gently slide the replacement board and cable into a long option slot until the edge connector firmly seats. |
| 5 | Connect the cable to connector J20 on the 4Z I/O board. |
-

6.3.5 Call Progress and Signaling Board (Option .35A or .35C) Replacement

Call Progress and Signaling (Option .35A or .35C) consists of a long option board (3735A-1-101 or 3735C-1010-01) and a short option board (3735A-2-101). Instructions for replacing both boards are provided in the following paragraphs.

6.3.5.1 Short Option Board

To remove the short option board (3735A-2-101), proceed as follows:

NOTE: The Call Progress and Signaling short option board may be piggyback-mounted to a second short option board.

Step	Replacing Short Option Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	Disconnect the cable from connector J12 on the Remote-Control board. This cable is part of the RS-232-C Interface connector and DIP switch on the CTS rear panel.
2	Gently lift the short option board until connector J27 on the side of the board is exposed. This cable connects to connector J28 on the Call Progress and Signaling long option board.
3	Disconnect the cable at connector J27 on the short option board.
4	Carefully lift the board until connector J26 is exposed.
5	Disconnect the cable at connector J26.
6	Carefully remove the short option board from the CTS. If piggyback-mounted to a second short option board, separate the two.
7	Connect cables to connectors J26 and J27 on the replacement board. If piggyback-mounted, first mount the short option board to the second board.
8	Gently slide the replacement board into a short option slot until the edge connector firmly seats.
9	Connect the cable to connector J12 on the Remote-Control board.

6.3.5.2 Long Option Board

To remove the long option board (3735A-1-101 or 3735C-1010-01), proceed as follows:

Step	Replacing Long Option Board
------	-----------------------------

CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.

- | | |
|---|---|
| 1 | Disconnect the cable from connector J12 on the Remote-Control board by applying steady and uniform pressure to the pull tab. This cable is part of the RS-232-C Interface connector and DIP switch on the CTS rear panel. |
| 2 | Gently lift the short option board until connector J27 on the side of the board is exposed. This cable connects to connector J28 on the Call Progress and Signaling long option board. |
| 3 | Disconnect the cable at connector J27 on the short option board. |
| 4 | Gently lift the Call Progress and Signaling long option board and cable from the CTS. |
| 5 | Gently slide the replacement board and cable into a long option slot until the edge connector firmly seats. |
| 6 | Connect the cable to connector J27 on the short option board. |
| 7 | Connect the cable to connector J12 on the Remote-Control board. |
-

6.3.6 ESF PCM Board (Option .64)
Replacement

To remove the ESF PCM board (3764-02, SMIUJ001AA), proceed as follows:

Step	Replacing ESF PCM Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	Unplug cables to connectors J4W and J4E on the ESF PCM board. These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.
2	Unplug cables to connectors J6, J3W, and J3E on the ESF PCM board. These cables connect to connectors J1, J2, and J3, respectively, on the T1 Bit Error Ratio board.
3	Using a flat screwdriver, gently pry up on extraction notches on the sides of the board until the connected cable at connector J5 is exposed.
4	Disconnect the cable to connector J5 on the side of the board.
5	Carefully remove the ESF PCM board.
6	Gently slide the replacement ESF PCM board into a long option slot but do not seat the edge connector.
7	Connect the cable to J5 on the left side of the board.
8	Firmly seat the replacement board in the Test Shelf.
9	Connect cables to connectors J4W, J4E, J6, J3W, and J3E on the ESF PCM board.

6.3.7 Master/Slave Board (Option .41) Replacement

To remove the Master/Slave board (3741-01, TETMET26AA), proceed as follows:

Step	Replacing Master/Slave Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	Disconnect the cable to connector J12 on the Remote-Control board. This cable is part of the RS-232-C Interface connector and DIP switch on the CTS rear panel.
2	Disconnect the cables to connectors J4W and J4E on the ESF PCM board. These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.
3	Unplug the cable from connector J23 on the Remote-Control board. This cable is part of the Master/Slave board.
4	Using a flat screwdriver, gently pry up on extraction notches on the sides of the Master/Slave board.
5	Carefully remove the Master/Slave board and cable from the CTS.
6	Gently install the replacement Master/Slave board into a CTS short option slot until the edge connector firmly seats.
7	Connect cables to connectors J23, J4W, J4E, and J12.

6.3.8 X-Y Outputs Board (Option .07)
Replacement

To remove the X-Y Outputs board (3700-10), proceed as follows:

Step	Replacing X-Y Outputs Board
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	Disconnect the cable at connector J29 on the X-Y Outputs board.
2	Disconnect cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
3	Using a flat screwdriver, gently pry up on extraction notches on the sides of the X-Y Outputs board.
4	Carefully remove the X-Y Outputs board from the CTS.
5	Gently slide the X-Y Outputs board into a short option slot until the edge connector firmly seats.
6	Connect cables to connectors J4W, J4E, and J29.

6.3.9 T1 Bit Error Ratio Board (Option .65) Replacement

To remove the T1 Bit Error Ratio board (3765-01, TEPQ569AAA), proceed as follows:

Step	Replacing T1 Bit Error Ratio Board
------	------------------------------------

CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.

- | | |
|---|--|
| 1 | Unplug cables from connectors J1, J2, and J3 of the T1 BER board. These cables go to connectors J6, J3W, and J3E, respectively, on the ESF PCM option board. |
| 2 | Using a flat screwdriver, gently pry up on extraction notches on the sides of the board. |
| 3 | Carefully remove the T1 BER board. |
| 4 | Gently slide the replacement T1 BER board into a long option slot until the edge connector firmly seats. |
| 5 | Connect cables to connectors J1, J2, and J3 on the T1 BER board. |
-

6.4 Packing and Shipping for Return to Factory

If a PC board within the unit needs to be returned to Hekimian for servicing, please contact Hekimian Customer Support at 1-800-321-0780. Your Customer Support Representative will ask for the following information:

- Type of repair or service required
- Model and serial number of the unit from which the PC board came
- Serial number of the PC board
- Return address.

Your Customer Support Representative will then assign a Return Authorization Number. Keep a copy of all information for yourself and refer to your copy in any correspondence with Hekimian.

PC boards are shipped enclosed in a special conductive envelope to protect the circuitry from static electricity. If a conductive envelope is unavailable, DO NOT wrap the board in an ordinary plastic bag or plastic sheeting. Instead, proceed as follows:

Step	PC Board Return Procedures
CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.	
1	If available, cover the entire edge connector with a conductive shorting bar.
2	Wrap the PC board in heavy kraft paper.
3	Insert the item in a double-walled shipping container. Surround it with 2 to 4 inches (5 to 10 cm) of thick shock-absorbing material.
4	Enclose the following information in the shipping container: • Type of repair or service required • Model and serial number of unit from which PC board came • Serial number of the PC board • Return address • Return Authorization Number
5	Mark the container: FRAGILE - DELICATE ELECTRONIC INSTRUMENT.

6.5 Warranty Information

LIMITED WARRANTIES - DISCLAIMER OF WARRANTIES

Subject to the provisions hereof, Seller warrants the equipment manufactured by Seller and provided to Buyer pursuant to these Terms (the "Equipment") against any defect in design, materials, and workmanship that materially affects its performance (a "Defect") for a period (the "Warranty Period") of one year from the date of delivery thereof, except that the Warranty Period shall be 90 days with respect to rechargeable batteries. Seller shall, at its option and expense in accordance with the procedures described below, repair or replace ("Service") any Equipment that proves to have a Defect during the Warranty Period. This limited warranty is contingent upon Buyer's notifying Seller in writing within ten days following Buyer's discovery of an alleged Defect, and in no event later than ten days following the Warranty Period. Upon authorization by Seller following Seller's receipt of written notice from Buyer, the Equipment may be returned for Service, prepaid and at the sole cost and expense of Buyer, to the facility designated by Seller in such authorization. If examination of the returned Equipment by or on behalf of Seller discloses that any Service performed is not within the scope of this limited warranty, Seller shall invoice Buyer for the costs of examination and Service and for the cost of return of the Equipment to Buyer, and Buyer shall pay costs within 30 days after receipt of such invoice. If such Service is within the scope of this limited warranty, Seller shall return the Equipment to Buyer at the sole cost and expense of Seller.

The limited warranty set forth herein shall not apply with respect to Defects resulting from neglect; misuse; accident; fire or other hazard; unauthorized alteration, modification or repair, including, without limitation, installation of unauthorized parts; improper testing, handling, storage, operation, interconnection, or installation after installation of the Equipment (provided, however, that minor adjustments by skilled personnel of Buyer following procedures prescribed by Seller will not invalidate such warranty); failure to continually provide a suitable central office operating environment (including any necessary electrical, air conditioning, or humidity systems); or any other cause beyond the range of normal usage of the Equipment (except, in all of the foregoing cases, when caused by Seller). This limited warranty shall terminate upon any sale of the Equipment by Buyer. Service of Equipment, in the manner and for the period of time set forth herein, shall be Buyer's exclusive remedy hereunder and shall constitute fulfillment of all liabilities of Seller to Buyer, whether based on contract, negligence or otherwise with respect to the Equipment delivered to Buyer hereunder. Seller reserves the right to make changes in the design or construction of any of its Equipment at any time without incurring any obligations to make any changes whatever on units previously purchased.

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*Model 3700 Option .72
EasyTest™ Editor/RAM Buffer
User's Manual*

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Imbedded Software and Documentation
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PREFACE

This manual is a supplement to the User's Manual that covers your Model 3700-series Communications Test System. This supplement provides information on the Option .72 EasyTest™ Editor/RAM Buffer. Option .72 is provided as a standard feature of the Option .25A-232 Remote Control.

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1 INTRODUCTION

This manual is a supplement to the User's Manual that covers your Model 3700-series Communications Test System. This supplement provides information on the Option .72 EasyTest™ Editor and EasyTest™ procedures. The EasyTest™ Editor, along with the Option .70 EasyTest™ Interpreter, are provided as standard features of Option .25A-232 Remote Control.

EasyTest™ procedures are programmed routines or "macro" instruction sets that contain procedural language commands. These procedures enable you to perform a complex test by entering one command.

NOTE: All current Option .25A commands are valid procedural language statements in their present format. They are the means by which 3700 test functions are invoked.

The EasyTest™ Interpreter is designed to allow the user the opportunity to sequence test set activity. Procedural language commands create great flexibility in the way the 3700 can interface with remote users. It is possible to perform alternative testing based on received signal status without remote user intervention; create test sequences; and store test results for delayed interpretation.

1.1 Hardware Requirements

The Option .25A-232 comes equipped with Option .74 RAM Buffer and has adequate RAM for Option .72 EasyTest™ Editor operation. The EasyTest™ Editor is located in an EPROM, along with the Option .70 EasyTest™ Interpreter, on the Option .25A-232 IC board.

At powerup, the 3700 checks for the presence of the EPROM with the EasyTest™ Editor and if present, enables EasyTest™ Editor entry. The presence of the editor may be determined by the DCAP command which displays .72 EASYTEST EDITOR as an installed option.

1.2 Nomenclature Conventions

An effort has been made to standardize format descriptions in this section. Angle brackets (< >) enclose keyword descriptions used in the procedural language. These angle brackets and descriptions are not intended to be interpreted literally. Optional elements are enclosed in square brackets ([]). Again the square brackets are not part of the language; but rather, are used to group the optional parameters.

1.3 Invoking the Editor

The EDIT command invokes the EasyTest™ Editor. If any firmware requirements of the editor are not installed, the 3700 sends the message E06 MOD ABST. The command has the following output format:

EDIT <proc name>

where the proc name is any valid procedure name. When the 3700 receives a valid EDIT command, it searches the directory to find the named procedure. If it is found, the procedure is copied into the editor work space and the first line displays with the line number 1. If the procedure name is new, the 3700 prints NEW FILE and automatically inserts an END statement.

NOTE: The 3700 indicates that it is in the editor mode by changing the prompt characters to read "E>".

1.4 Cursor Guidelines

The cursor points to a location within the editor work space. It always points to the beginning of a line and all editing commands occur relative to its position. Any insertions into a procedure being edited occur immediately before the line pointed to by the cursor, and all deletions occur starting with the line pointed to by the cursor.

2 EASYTEST™ EDITOR COMMANDS

The following list contains the commands which may be used in the Option .72 EasyTest™ Editor to edit a procedure:

DEL(ete)	LINE
DIR(ectory)	LIST
D(own)	QUIT
ERASE	T(ype)
GET	TYPE
I(nsert)	SAVE
INSERT	U(p)
L(ine)	

This section describes the syntax and function of these commands. While in the line editor mode, the 3700 HELP command provides a list of the valid editor commands.

2.1 Directory

The directory listing can be shown with the DIR command. The listing shows the size and status along with name of all procedures known to the system. The DIR command also displays the ID number of the EasyTest™ procedure set resident in read-only memory (ROM) and the size of the unused portion of RAM. The EasyTest™ procedure set ID number has the following form:

. 71 - xxx

where $001 \leq xxx \leq 999$.

2.2 List

The LIST command is used to view the contents of a procedure (other than the one in the editor work space) while not aborting the current edit session. This command may also be used outside the editor to read the text of a procedure. This command has the following output format:

LIST <proc name>

where proc name refers to any already existing procedure.

2.3 Get

The GET command loads an entire procedure into the editor work space, inserting it before the current line. Caution should be used when using the GET command as it also transfers the end statement, which then must be deleted from the procedure being edited. This command has the following output format:

GET <proc name>

where proc name refers to any already existing procedure.

2.4 Type

The TYPE command lists the specified number of lines beginning with the current line. If a number greater than the number of lines from the current line to the end of the procedure is specified, this command types out the remaining lines and displays the message END OF FILE. If no number of lines is specified, the editor types one line. This command has the following output formats:

T <number of lines>

TYPE <number of lines>

where line number may take any value from 1 through 999.

2.5 Down and Up

The Down and Up commands are used to move about within the editor work space. They move the cursor one line for each time they are used. These statements have the following output formats:

D
U

2.6 Line

The LINE command positions the cursor within the editor work space. This command sets the cursor to the line number indicated in the command. If the line number specified is greater than the total number of lines in the procedure, the cursor is placed at the last line in the procedure. This command has the following output formats:

L <line number>
LINE <line number>

where line number may take any value from 1 through 999.

2.7 Insert

The INSERT command causes all input characters to be stored immediately preceding the current line. No distinction is made between printable and control characters. Two consecutive carriage returns causes an exit from the INSERT mode and restores the editor prompt. This command has the following output formats:

I
INSERT

2.8 Delete

The DEL (delete) command is used to remove lines from the editor work space. The user may specify the number of lines to be deleted; however, if this parameter is omitted, a single line is removed. Deletion takes place starting with the current line and continuing for the specified number of lines. If a number larger than the number of lines remaining in the work space is specified, all lines from the current line thru the end of the work space are deleted except for the END statement. This statement has the following output format :

DEL <number of lines>

where the number of lines may take any value from 0 through 999.

2.9 Save

The SAVE command is used to exit the line editor and store the contents of the work space as a procedure with the name specified in the EDIT command. If the procedure updates an existing procedure contained in ROM, a new directory entry is created with the same name, and the procedure in ROM is flagged as having been superseded. A command invoking that name executes the procedure in RAM. If the new procedure is erased, the procedure in ROM is again enabled. If a new procedure updates an existing procedure in RAM, the previous procedure is automatically erased during the saving process. This command has the following output format:

SAVE

2.10 Quit

The QUIT command ends the editor session without storing the work space or updating the current directory. This command has the following output format:

QUIT

2.11 Erase

Procedures that exist in RAM may be deleted using the ERASE command. If a procedure in RAM that supersedes a procedure in ROM is erased, the procedure in ROM is again enabled. When a procedure is deleted, the remaining procedures in memory are compacted to preserve space. The command has the following output format:

ERASE <proc name>

3 EASYTEST™ PROGRAMMING STATEMENTS

EasyTest™ programming statements create a framework upon which test sequences are created and executed. The following is a list of EasyTest™ statements:

AMSG	IF
CLEAR	INC
DEC	LABEL
ELSE	MSG
END	PROC
ENDIF	SET
EXIT	STOP
GOTO	WAIT

3.1 General Statements

PROC: One procedure may "call another," nesting up to ten levels deep. If a proc tries to go deeper than ten levels, the procedure halts and an error message displays.

END: The END statement must be the last statement in a procedure and terminates its execution. If an END statement is encountered in a called procedure, control reverts to the previous procedure. This statement has the following output format:

END

EXIT: The EXIT statement may occur anywhere within a procedure except as the last statement. This statement acts functionally like an END statement. This statement has the following output format:

EXIT

STOP: This statement terminates procedure operation from any level of nesting. This statement has the following output format:

STOP

3.2 Message Statements

Message statements are used for generating information or error statements.

MSG: The MSG statement generates a message on a new display line. This statement has the following output format:

MSG <text of message>

AMSG: The AMSG statement appends the message to the currently displayed line. This statement has the following output format:

AMSG <text of message>

LABEL: The EasyTest™ Interpreter allows for the setting of up to ten labels used to divert procedure execution flow. Labels are designated 0 through 9. At powerup, all labels are undefined. This statement has the following output format:

LABEL <label number>

GOTO: GOTOs across nesting levels are allowed, but are considered poor programming practice. This statement has the following output format:

GOTO <label number>

This statement diverts procedure flow to the statement following a previously executed LABEL statement. ERR 1 - LABEL UNDEFINED returns if the LABEL statement has not been previously encountered.

IF, ELSE Statements: The use of IF statements allows conditional processing within procedures. IF statements may be nested up to 255 levels. When an IF statement is encountered, it is evaluated as true or false. Statements are executed following a true condition and ignored following a false condition until an ENDIF statement is encountered. An ELSE statement directs the execution flow if a false condition exists. IF sequences need not be followed by an ELSE statement; however, an ELSE statement must be preceded by an IF. This statement has the following output format:

ELSE

IF TIMEOUT: This condition can be used after certain WAIT statements and is true if the specified timeout period was exceeded. The timeout flag is set conditionally by the WAIT LEVEL and WAIT FREQUENCY statements. This statement has the following output format:

IF TIMEOUT

IF NO TIMEOUT: The condition is true if the specified timeout period was not exceeded. This statement has the following output format:

IF NO TIMEOUT

IF PARAMETER: This command returns true if the referenced parameter has been defined. Any user-definable parameter may be tested. These parameters are P1-P6, L1-L3, and COUNT. This statement has the following output format:

IF P2

IF PARAMETER EQUAL TO INTEGER: This statement tests the value of a variable and returns true if the variable equals the specified value. Any of the global or local parameters may be tested along with a variable called COUNT. The variables are referenced P1 through P6, L1 through L3, and COUNT. The comparison value may range from 0 through 9999. Using this constraint allows the use of any variable as a counter and enables two variables to be compared to each other. This statement has the following output format:

IF COUNT = <value> or IF P1 = <value>

IF PARAMETER EQUAL TO STRING: This statement tests the value of the parameter specified and returns true if the parameter is an exact match of the specified string. In the string specification, an X is a don't care character and matches any character at that location. The string " " is the null string and returns true only if the parameter to be tested has not been defined. This statement has the following output format:

```
IF P1 = "string"
```

One can also compare two parameter values by using this IF statement.

```
IF P1 = *P2
```

IF SLAVE: This statement evaluates true if the unit running the procedure is a slave under Option .41 Master/Slave operation. This statement has the following output format:

```
IF SLAVE
```

IF TIMER: This statement evaluates true when an integrating measurement is in progress. This statement has the following output format:

```
IF TIMER
```

IF CHANGE: This statement looks for a change in a 3700 receive signal frequency and evaluates true if the change is greater than or equal to the specified increment. A true condition causes the new value to be stored for subsequent change testing. This command works when the 3700 is measuring level, noise, impulse noise, hits/dropouts, jitter or envelope delay. When not measuring one of these parameters, the test results are indeterminate. This statement has the following output format:

```
IF CHANGE <increment>
```

where increment is xx.xx kHz.

IF CLOCK: This statement checks a continuous system clock for an elapsed time equal to or greater than the specified number of seconds. It returns true if the indicated time has elapsed. This statement enables the creation of synchronized procedures. This clock may assume a value from 0 through 9999 seconds (>2.75 hours). When starting a synchronous test, the clock should be reset with a CLEAR CLOCK command. This statement has the following output format:

```
IF CLOCK <time value>
```

where time value is xxxx seconds.

IF FUNCTION: The IF FUNCTION statement accepts any 3700 opcode and an ASCII string. It evaluates true if the string is a subset of the results of the test. An X within the string maintains its position, but matches any character. This statement has the following output format:

IF (<opcode>) = "string"

As an example, IF (MLVL) = 0.XDBM evaluates true for the following level ranges: +10.0 DBM, +0.9DBM through -0.9DBM, -10.0DBM through -10.9DBM, -20.0DBM through -20.9DBM, -30.0DBM through -30.9DBM, etc.

IF KEY: The IF KEY statement compares the last character received by the 3700 with the character specified in the command. This allows the user to interact with a procedure while it is running (i.e., menu-driven procs). This statement has the following output format:

IF KEY = "<character>"

ENDIF: This statement terminates an IF block. This statement has the following output format:

ENDIF

3.3 Parameter Statements

Parameters are provided for loop control and condition passing as well as passing of text messages. When used for numbers, parameters may assume a value of 0 through 9999 and their value may be tested with the IF PARAMETER series of statements. The value of all parameters (except for the three local) are maintained outside of the procedure and retain their value unless redefined. This allows for their use as a passable variable.

SET PARAMETER: This statement causes the specified value to be stored in the appropriate parameter variable. This statement has the following output format:

SET P1 = <new parameter value>

where the new value may be any number from 0 through 9999 or an ASCII string enclosed in double quote marks.

DEC PARAMETER: This statement causes the value stored in PARAMETER to be decreased. If the value was already zero, the statement has no effect. If the parameter does not contain a numeric variable, the DEC statement returns the message ERR 3 -TYPE ERROR. This statement has the following output format:

INC P1

3.4 Wait Statements

The 3700 procedural language allows execution of procedures to wait for the occurrence of various events before proceeding. An event which may never occur has a selectable timeout period associated with it. If no time is given, the time is set at zero and a timeout occurs if the condition waited for is not present. Times may assume the range 0 through 99.9 seconds.

WAIT TIME: This statement is a timing WAIT and suspends execution for the specified interval. Allowed intervals are from 0 through 99.9 seconds. An omitted time is assumed to be zero. This statement does not affect timeout validity for the IF TIMEOUT statement. This statement has the following output format:

```
WAIT TIME = <time to wait>SEC  
WAIT T = <time to wait>SEC
```

where time to wait is in the form of xx.x.

WAIT TIMER: This statement causes execution to be suspended until the 3700 integrating measure timer stops. There is no timeout associated with this WAIT. This statement has the following output format:

```
WAIT TIMER
```

WAIT LEVEL: This statement tests for a receive level between the specified ranges. If either the high or low range is omitted, the specified limits of the 3700 are inserted (+10.0 to -70.0 dbm). The statement causes suspension of the procedure until a level between the two limits is read, or until the specified time elapses. This statement has the following output format:

```
WAIT LEVEL = <low limit> DBML <high limit> DBMH  
T = <timeout>SEC  
WAIT L = <low limit> DBML <high limit> DBMH  
TIME = <timeout>SEC
```

where <low limit> and <high limit> are in the form $\pm xx.x$ and the <timeout> is in the form xx.x.

WAIT FREQUENCY: This statement tests for a receive frequency between the specified ranges. The high and low ranges for frequency are 0.04 kHz on the low side and 20.01 kHz for a high limit. The resolution of this test is 10 Hz. This statement has the following output format:

```
WAIT FREQ = <low limit> LL <high limit> HL  
T = <timeout>SEC  
WAIT F = <low limit> LL <high limit> HL  
TIME = <timeout>SEC
```

where <low limit> and <high limit> are in the form xx.x and the <timeout> is in the form xx.x.

WAIT SLAVE: This statement is used to coordinate Master/Slave procedures where independent procedures are being run in each unit. This statement holds up the execution of procedure statements by the master until the slave has completed its procedure. This statement has the following output format:

```
WAIT SLAVE
```

3.5 Miscellaneous Statements

CLEAR CLOCK: This statement sets the system clock to zero elapsed time. This statement has the following output format:

```
CLEAR CLOCK
```

INC FREQUENCY: This statement increments the send frequency by the specified amount. If the frequency is at the upper limit, or less than the incremental amount from it, the send frequency is set to the upper limit. If no increment is specified, the default of 100 Hz is used. This statement has the following output format:

```
INC FREQ <increment value> KHZ
```

where increment value is in the form of xx.xx.

4 SYNTAX REQUIREMENTS

The 3700 accepts one or more spaces, a comma with or without blanks either before or after, and in some cases an "=" sign as parameter or field separators.

When a numeric parameter is given in units, they must be entered as shown immediately following the final digit. If a sign is specified, the variable is assumed to be positive if none is entered. If the specified format is xx.xSEC, then xx.SEC, x.SEC, .xSEC, and x.xSEC are acceptable entry formats. The following entry formats are not acceptable:

xS -- Incorrectly specified units
xxxSEC -- Too many digits to the left of the decimal point
.xxSEC -- Too many digits to the right of the decimal point
xx.x SEC -- Space between digits and units.

5 EASYTEST™ PROCEDURE FORMAT

An EasyTest™ procedure (proc) contains one or more statements from the procedural language or the 3700 test command set. The last statement in a proc must be on a separate line and be terminated with a carriage return.

NOTE: As more than one space is ignored on command lines, spaces are used in the examples given to enhance readability.

5.1 Procedure Names

A proc name contains from 1 to 8 characters from the printable ASCII character set. Caution should be taken if using *P1 - *P6 or *L1 - *L3 in a name statement, as these sequences are parameter substitution designators.

Invoking a Procedure: A proc is executed by sending to the 3700 a proc statement. This statement has the following output format:

```
PROC <proc name> [V] [AGLOBAL1; . . . GLOBAL6]  
[ ~LOCAL1; . . . LOCAL3 ]
```

where any number of blanks may occur between the statement identifier, the proc name, and the parameter start character. Any blank within the parameter field is treated as part of the parameter. A semicolon between parameters is mandatory, but may or may not be included after the last one. If it is not necessary to specify any parameters, this field may be omitted.

Upon receipt of a proc statement the 3700 searches for the designated procedure and, if found, starts its execution. If the specified procedure does not exist, the message E01 INV CMND returns.

Aborting a Procedure: To abort a procedure in progress, send a CTRL-A (ASCII 01). This interrupts the procedure and return a prompt.

NOTE: Data buffering may have been left active, and it may be necessary to perform an SBUF OFF DUMP command to restore normal operation.

5.2 Procedure Parameters

When a procedure is invoked, it may pass up to six global and three local parameters. These parameters may consist of 0 (NULL STRING) through 20 characters and contain any character except ";". These parameters are stored as text strings and the global parameters are altered only by powering down the 3700 or by again defining the parameter. The list of global parameters is always preceded by Λ (ASCII 5E) and the list of local parameters is always preceded by ~ (ASCII 7E).

Parameters are position dependent within the entry string and are stored and referenced in the order they are entered. If only the 3rd global parameter is to be specified, the entry must read Λ; <GLOBAL 3>, where the semicolons are used to indicate unused parameters. In this case, the first two parameters would be set equal to the null string. If it is desired to change the 3rd parameter without altering the first two, the entry should read Λ*P1; *P2; <GLOBAL 3>. Parameters may also be swapped when invoked by inserting one designator string into another position (Λ*P2; *P1). The parameters are referenced by the character sequences *P1 through *P6 for global parameters and *L1 through *L3 for local variables. Use of one of these sequences in a command line causes the sequence to be replaced by the referenced parameter. At powerup, all parameters equal null strings.

Global parameters maintain the same value for all subroutines which may be invoked by the highest level procedure, while local variables are known only to the presently executing procedure. Local variables are stored and restored as a procedure invokes and returns from subprocedures.

Parameters may be used to hold text strings or numeric variables. If numbers are used, they may be in the range of 0 through 9999. As an illustration of the use of parameters, consider the following procs:

TEST defined as:

```
MSG TEST DATE:  *L1
SSND *P1 *P2
PROC LEVEL ~ .4KHZ
PROC LEVEL ~ 1.0KHZ
PROC LEVEL ~ 2.8KHZ
MSG TEST COMPLETED *L1
END
```

and LEVEL defined as:

```
SSND *L1
WAIT T=*P3SEC
MLVL
END
```

If the procedure TEST were invoked as follows:

```
PROC TEST A0DBM;1KHZ;3~6/14/91
```

it would print the message TEST DATE: 6/14/91, set the generator to send 1 kHz at 0 dBm, call the subroutine LEVEL three times, and finally display the message TEST COMPLETED 6/14/91. Each time the procedure LEVEL is called, it would set a new send frequency, wait three seconds, and then take a level measurement.

5.3 Verify Option

When a procedure is being executed, no output except the actual test data is sent to the user. In order to assist in the creation and debugging of user-written procedures, the VERIFY option may be specified in the proc command string. When the VERIFY option is specified, the 3700 prints each command immediately before executing it. The VERIFY option is invoked by including the parameter V on the proc invocation command line. The VERIFY option has the following form:

```
PROC <proc name> V AGLOBAL 1 [;...GLOBAL 6]  
~ LOCAL 1 [;...LOCAL 3]
```

NOTE: If this option is specified after the global or local parameter character, the semicolons designating unused positions must be included.

6 PROGRAMMING TECHNIQUES

This section uses sample procedures to illustrate possible uses of the procedural language. All uses and cases are not covered due to space limitations; however, most general programming structures are illustrated.

6.1 Writing Test Sequencing EasyTest™ Procedures

The simplest use of the procedural language is as a test sequence. The following procedure measures impulse noise, hits, and dropouts for an operator selectable interval, displaying the current counts on an input interval. When the integrating measure is over, it measures phase jitter, noise, level and frequency. The following command would be used to invoke this procedure:

```
PROC TEST1 A5;1.0
```


where TEST1 is the following procedure:

```
MIHD *P1MIN *P2INT
MPHJ
MNSE
MLVL
END
```

The first parameter controls the length of the integrating measure, and the second parameter determines the interval on which intermediate results are returned. This proc causes the 3700 to execute the given sequence of commands before returning control to the remote user. Receipt of a prompt (->) indicates user control.

6.2 Looping

The LABEL, GOTO and IF statements allow the programming of loops. The following example illustrates a portion of a procedure which measures level and frequency every five seconds for a parameter selected number of times. When the selected number of repetitions are finished, the message LEVEL LOOP FINISHED displays and execution proceeds to the statement following the ENDIF.

```
SET COUNT =*P1           Count set to parameter value
LABEL 0
WAIT T = 5SEC
MLVL
DEC COUNT
IF COUNT = 0
MSG LEVEL LOOP FINISHED
ELSE
GOTO 0
ENDIF
```

Looping can also be done while waiting for a condition to occur. The following example of procedural code illustrates a wait for one minute or a valid level before continuing.

```
SET COUNT=12
LABEL 2
WAIT LEVEL T=5SEC
IF TIMEOUT
DEC COUNT
IF COUNT=0
MSG INVALID LEVEL
ELSE
GOTO 2
ENDIF
ELSE
MSG LEVEL IN RANGE
ENDIF
```

NOTE: By not specifying any level range, the default range is -70 to +10dBm.

6.3 Subroutines

Any procedure may be used as a subroutine by executing a proc statement within a procedure. It is a good practice to put commonly used blocks of code into a separate procedure as this saves memory space. The following procedure makes use of the previously defined TEST1 procedure. It performs the same measurement sequence an operator-selected number of times, but only displays the hits/dropout counter once in a cycle. The following command would be used to invoke this procedure:

```
PROC TEST2 A5;12
```

where the 1st parameter is the length of time for the integrating measure test and the 2nd is the parameter number of repetitions.

```
SET COUNT =*P2          Count set to number of repetitions
LABEL 0                 Looping entry point set
PROC TEST1 A*P1;*P1
DEC COUNT
IF COUNT = 0
EXIT
ELSE
GOTO 0
END
```

NOTE: P2 is set to P1, the print interval in PROC TEST1 equals the test length.

When PROC TEST1 reaches its END statement, control proceeds to the DEC COUNT statement.

7 EASYTEST™ PROCEDURE EXAMPLE

This procedure is included as an example of possible uses of EasyTest™ procs. This procedure monitors the receive frequency and causes the level and frequency to be measured whenever the frequency changes by more than 50 Hz. If the frequency does not change by 50 Hz in 10 seconds or does not stabilize for 0.5 seconds, an error message displays. This procedure calls a subroutine which checks for a 50 Hz frequency change. The called procedure in turn calls a subroutine which checks for a stabilized reading. The first procedure has no parameters and is invoked as follows:

```
PROC RXFSWP
```

where RXFSWP is defined:

SLVL	Enable frequency detection.
LABEL 1	
PROC FCHNGE	Subroutine called.
IF COUNT=0	Count variable used to pass status from subroutine to caller.
MLVL	
ELSE	
MSG NO VALID READING IN 10 SECONDS	
ENDIF	
GOTO 1	
END	

NOTE: Operator terminates this procedure.

PROC FCHNGE

where FCHNGE is defined:

SET COUNT=15	Count to control loop.
LABEL 9	
IF COUNT=0	If at end of wait period count is used to pass status to caller.
SET COUNT=1	
EXIT	
ENDIF	
IF CHANGE .05KHZ	
PROC SETTLE	Stabilize reading.
IF COUNT=0	
EXIT	
ELSE	
DEC COUNT	
GOTO 9	
ENDIF	
ELSE	
WAIT T=.3SEC	
DEC COUNT	
ENDIF	
GOTO 9	
END	

PROC SETTLE

where SETTLE is defined:

```
WAIT T=.5SEC
IF CHANGE .01KHZ
WAIT T=.5SEC
IF CHANGE .01KHZ
WAIT T=.5SEC
IF CHANGE .01KHZ
EXIT
ELSE
SET COUNT=0
EXIT
ENDIF
ELSE
SET COUNT=0
EXIT
ENDIF
END
```


GLOSSARY

Acronyms, Abbreviations or Initialisms

2W	Two-wire circuit
3IN24	3-in-24 stress pattern
4W	Four-wire circuit
AIS	Alarm Indication Signal
ANSI	American National Standards Institute
AMI	Alternate Mark Inversion
ASC	Abnormal Station Condition
ASCII	American Standard Code for Information Interchange
AutoREACT	Hekimian's Automated Remote Access and Test System
B3ZS	Bipolar Three Zero Substitution
B8ZS	Bipolar Eight Zero Substitution
Bellcore	Bell Communications Research, Inc.
BER	Bit Error Rate
BER	Bit Error Ratio
BERT	Bit Error Rate Test
Bisync	Binary synchronous communication
bit	Binary digit
BOC	Bell Operating Company
BPNRZ	Bipolar Non-Return-to-Zero
BPRZ	Bipolar Return-to-Zero
bps	Bits per second
BPV	Bipolar Violation
CAC	Customer Access Code
CCS	Common Channel Signaling
CCITT	International Telegraph and Telephone Consultative Committee
CEPT	European Conference of Postal and Telecommunications Administrations
CGN	Connector Group Network
CGNC	Connector Group Network Controller
CID	Craft Interface Device
CIT	Craft Interface Terminal
CGN	Connector Group Network
CGNC	Connector Group Network Controller
CLCI™	Common Language® Circuit Identification codes
CLEI™	Common Language Equipment Identification codes
CLFI™	Common Language Facility Identification codes
CLLI™	Common Language Location Identification codes

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CMI	Control Mode Idle
CO	Central Office
COS	Code-Operated Switch
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CRC6	Cyclic Redundancy Check Error
CSU	Channel Service Unit or Customer Service Unit
CTC	Centralized Test Center
CTS	Communications Test System
DATS	Digital-Analog Test System
dBm	Decibel (dB) referenced to 1 milliwatt
dBm	Decibels above reference noise
DCE	Data Communications Equipment
DCE	Data Circuit-Terminating Equipment
DCS	Digital Cross-connect System
DDS	Digital Data System or Digital Data Service
DEC™	Digital Equipment Corporation
DLC	Digital Loop Carrier
DN	Distribution Network
DO	Drop Out
DPMU	Digital Performance Monitoring Unit (Hekimian Model 3249)
DPU	DS1 Performance Unit (Hekimian Model 6301)
DRTU	Digital Remote Test Unit (Hekimian Model 6700)
DS1	Digital Signal at level 1
DS3	Digital Signal at level 3
DSA	Digital Serving Area
DSAU	DS1 Signal Access Unit
DSU	Data Service Unit
DSX	Digital Signal Cross-connect
DTAS	Digital Test Access System
DTAU	DS1 Test Access Unit
DTAU+	Digital Test Access Unit Plus
DTE	Data Terminal Equipment
DTMF	Dual-tone multifrequency
DTR	Data Terminal Ready
DTU	DDS Test Unit (Hekimian Model 6302)
EC	Error correction
EDSX	Electronic Digital Signal Cross-connect
EDSX-1	Electronic Digital Signal Cross-connect, DS1 level
EDSX-3	Electronic Digital Signal Cross-connect, DS3 level
EDD	Envelope Delay Distortion
EFS	Error Free Second
EIA	Electronic Industries Association
EM+	Enhanced Monitor Plus
EM/MU	Enhanced Monitor/Matrix Unit
ERL	Echo Return Loss
ERRSEC	Errored Seconds
ES	Errored Second
ESF	Extended Superframe
EZ	Excessive zeros
FAD	Facility Access Digroup
FBE	Framing Bit Error

FDL	Facility Data Link
FDM	Frequency Division Multiplexing
FE	Framing Error
FEBE	Far-End Block Error
FEV	Far-End Voice
FPS	Framing Pattern Sequence
FRMBE	Framing Bit Errors
F_s	Signaling Framing
F_t	Terminal Framing
FT1	Fractional T1
FX	Foreign Exchange
GDD	Group Delay Distortion
GH	Gain Hit
GHT_h	Gain Hit Threshold
HCDS	High Capacity Digital Services
HDB3	High Density Bipolar Three
HDLC	High Level Data Link Control
HiCap	High Capacity Digital Services
HSC	Hierarchical Storage Controller
IEC	Interexchange Carrier
IMD	Intermodulation Distortion
INV SIG	Inverted Signal
IPR	Inside Plant Repeater
ISU	Intermediate switching unit
IXC	Interexchange Carrier
JKLP	Jack, Key and Lamp Access Panel
KA	Keep Alive signal
kbps	Kilobits (10 ³) per second
LATA	Local Access and Transport Area
LATS	Loop Access Test System
LBE	Loopback Enable
LIU	Line Interface Unit
LOS	Loss of Signal
LPDA	Link Problem Determination Aid (IBM®)
LRC	Longitudinal Redundancy Check
LSA	Local Serving Area
LSC	Loopback Select Code
LTP	Local Test Port
LTPCU	Local Test Port Control Unit
M13	DS1-to-DS3 Multiplexer
MA	MJU Alert
MAP	Minimum Acceptable Performance
Mbps	Megabits (10 ⁶) per second
MC	Maintenance Connector
MCC	Maintenance Connector Controller
MCN	Maintenance Connector Network
MF	Multifrequency
MIN	Minutes
MIU	Metallic Interface Unit
M/MU	Monitor/Matrix Unit
MJU	Multipoint Junction Unit
MOS	MUX Out of Sync

MTAU	Metallic Test Access Unit
MUX	Multiplexer
NETVIEW	Network Management System (IBM)
NICU	Network Interface Control Unit
NRZI	Non-Return to Zero Inverted
OCU	Office Channel Unit
OOF	Out Of Frame
OOS	Out Of Service
OOS	Out Of Sync
OPR	Outside Plant Repeater
OS	Operations System
OSS	Operations Support System
PA/D	Packet Assembler/Disassembler
P/AR	Peak-to-Average Ratio
PCM	Pulse Code Modulation
PCO	Plant Control Office
PH	Phase Hit
PHTh	Phase Hit Threshold
PID	Process Identification
PMC	Phantom Maintenance Connector
POP	Point of Presence
PPSN	Public Packet Switched Network
proc	Procedure
PRBS	Pseudo-Random Binary Sequence
PSDS	Public Switched Digital Service
PSU	Power Supply Unit
PTSU	Protection Transmission Switching Unit
PVC	Permanent Virtual Circuit
PVS®	Protocol Vital Signs™
QRSS	Quasi-Random Signal Source
QRSS-ERR	QRSS Error
RAM	Random Access Memory
RAU	Relay Access Unit (Hekimian Model 3204)
RDL	Remote Digital Loop
REACT	Hekimian's Remote Access and Test System
RML	Remote Maintenance Loopback
ROM	Read-Only Memory
RRO	Responsible Repair Organization
RTP	Remote Test Port
RTPP	Remote Test Port Panel
RTS-5A	Remote Test System 5A
S1DN	Stage 1 Distribution Network
SARTS	Switched Access Remote Test System (AT&T)
SBPV	Severe bipolar violations
SCP	Service Control Point
SCRC6	Severe Cyclic Redundancy Check Error
SERRSEC	Severely Errored Seconds
SES	Severely Errored Seconds
SF	Single frequency
SF	Superframed
SFE	Severe Framing Error
SLC™-96	Subscriber Loop Carrier 96-channel system (AT&T)

SLU	Spare Line Unit
SMAS	Switched Maintenance Access System (AT&T)
SMJ	SmartJack
SNA	System Network Architecture (IBM Protocol)
SRDC	Subrate Digital Cross-connect
SRDM	Subrate Digital Multiplexer
SSP	Service Switching Point
SQRSS-ERR	Severe QRSS error
STP	Signaling Transfer Point
SVC	Switched Virtual Circuit
SYSGEN	System Generation
T1DM	T1 Digital Multiplexer
TA	Test Alert
TAD	Test Access Digroup
TAIU	Test Access Interface Unit
TAU	Test Access Unit
TBIU	Test Bus Interface Unit
TCU	Transmission Control Unit
TDM	Time Division Multiplexing
TEIU	Test Equipment Interface Unit
TIC	Test Interface Controller
TIRKS	Trunks Integrated Records Keeping System (Bellcore)
TIP	Transition In Progress
TL1	Transaction Language 1
TLP	Transmission Level Point
TLPM	T1 Line Performance Monitor (Hekimian Model 3246)
TPMU	T1 Performance Monitoring Unit (Hekimian Model 3248)
TPT	Test progress tone
TSPM	T1 Service Performance Monitor
UF	Unframed
UMC	Unassigned MUX Channel
USTA	United States Telephone Association
VAX™	Virtual Address eXtension
VDT	Video display terminal
VF	Voice frequency
VMS™	Virtual Memory System
YEL	Yellow alarm or remote alarm
ZBTSI	Zero-Byte Time Slot Interchange

Definitions

3-in-24 stress pattern Toughest pattern available for testing repeaters. Consists of 3 ones in 24 bits. Meets the T1 requirements of the minimum 12.5% ones density and no more than 15 zeros in a row (F0100 0100 0000 0000 0000 0100).

A and Z direction For a two-point circuit, one end is A and the other end is Z. For a multipoint circuit, the master station is A and the remote stations or terminals are Z.

Abnormal Station Code Network control code S0011110.

Acceptance Mask A collection of thresholds assigned to circuit performance parameters. When used during circuit testing, automatically reports whether a particular performance parameter has failed.

Alarm Indication Signal (AIS) An unframed All Ones signal that replaces the normal traffic signal when a maintenance alarm indication has been activated. Also called a **blue alarm**.

All Ones code A signal stream containing 15,360 or less zeros in one second. When a device loses synchronization, it sends an All Ones code to keep the network up. It also sends this code to tell the tester there is a transmission problem.

Alternate Mark Inversion (AMI) A pseudo-ternary signal that conveys **binary digits**. In this signal, successive marks normally alternate between positive and negative polarity. The marks are equal in amplitude. A space designates zero amplitude. Another term for this is bipolar signal.

American Standard Code for Information Interchange (ASCII) A code with seven information signals plus one parity check signal. It is useful for interworking between computers.

analog In communications, transmission employing variable and continuous waveforms to represent information values.

analog signal A nominally continuous electrical signal that varies in amplitude or frequency.

asynchronous error measurement A measurement that detects error events referenced by the system's time clock.

asynchronous transmission Transmission in which time intervals between transmitted characters may be of unequal length. Transmission is controlled by start and stop bits at the beginning and end of each character.

attribute An occurrence that can be detected and reported by the Hekimian Model 3246 T1 Line Performance Monitor (TLPM) or Model 3248 T1 Service Performance Monitor (TSPM).

autoframe A process which determines the framing on the line and reports the framing format.

back up To copy a disk for safe keeping.

bandpass filter A circuit designed to allow only frequencies within a specific range to pass. The cutoff frequencies must be finite and nonzero. The band of frequencies between the cutoff frequencies is the passband.

bandwidth The range of frequencies available for signaling; the difference between the highest and lowest frequencies of a band, expressed in Hertz.

baseband Describing the band of frequencies occupied by a signal below the point that the signal is modulated as an analog carrier frequency.

baud A unit of transmission speed. It represents the number of discrete signaling elements transmitted in one second.

benchmark A value used for comparison. For example, when a circuit is first put into service, it is tested for its transmission characteristics. These values are typically recorded and used for comparison when later testing becomes necessary on that circuit.

binary digit The smallest piece of digital information possible.

bipolar A 2-state code where successive "1" signals alternate between positive and negative polarity.

bipolar coding A T-carrier line coding system. This system inverts the polarity of alternate 1's bits.

Bipolar Eight Zero Substitution (B8ZS) A line-coding format for T1 lines that uses BPVs to encode strings of eight consecutive zeros. This coding format makes sure that the minimum pulse-density requirements are met without pulse-stuffing. This is true even for long strings of data zeros.

Bipolar Return-to-Zero (BPRZ) A 3-level code in which alternate ones change in sign. (For example, 1011 becomes +1, 0, -1, +1.) Also, transitions between adjacent ones pause at the zero voltage level.

Bipolar Three Zero Substitution (B3ZS) A line-coding format for DS3 signals that uses BPVs to encode strings of three consecutive zeros. The polarity of the BPV inserted depends on the preceding pulses.

bipolar violation A condition which occurs when a bit stream contains a pulse of the same polarity as the previous pulse and which is not part of a bipolar zero substitution code (e.g., B8ZS for a DS1 signal or B3ZS for a DS3 signal).

bipolar violation ratio The number of accumulated BPVs in the last monitored interval divided by the number of bits in that interval. Any one second where there is an LOS condition is not included in this computation.

Bisync (binary synchronous communication) IBM protocol - Block mode operation.

bit (binary digit) Contraction of "binary digits," the smallest unit of information in a binary system; a one or zero condition.

bit error The bit received in the data pattern is different from the one expected. This means the value of an encoded bit has changed during transmission. When this happens, the receiving end interprets the bit incorrectly.

bit error count The total number of bit errors counted during a timed test.

bit error rate The number of bit errors in a given group of bits or the ratio of errored bits to transmitted bits. Is usually expressed as a power of 10. Orders of 10^{-6} or fewer are the goal in digital transmission, while 10^{-4} are marginally acceptable for voice transmissions. (This does not include frame bits, CRC-6 bits, and data link bits.)

bit error ratio The ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

bit robbing The technique used to allow the digital data in the DS1 stream to carry the signaling supervision. The least significant bit per channel in every sixth frame carries the signaling.

bit stuffing The process of adding extra bits to the incoming customer data. These bits permit synchronization and signaling.

block error One or more bits in a 1-second window are in error.

blue alarm Notifies facilities at the receive end of a circuit that a red alarm has occurred at the transmit end of the circuit. Also called an **alarm indication signal**.

boot To start a computer from power off.

BPV code A specific BPV sequence purposely introduced to the local loop for network control.

BPV count The total number of BPVs counted during a timed test interval.

BPV rate The rate of erroneous received data bits to total received data bits. This excludes framing bits, CRC-6 bits, or data link bits.

bridging connection A parallel connection that draws some of the signal energy from a circuit, often with inconsequential effect on the circuit's operation.

byte A group of eight consecutive binary digits associated with a single user. A byte is typically the smallest addressable unit of information in a database or memory.

byte stuffing A technique which increases the speed of a digital stream by repeating bytes and transmitting them at a faster rate. This does not increase the information content of the stream.

C-Message noise Noise level measured on a channel in the absence of signal (voiceband).

C-Notched noise Noise level measured with a 1004-Hz signal present, but removed at the measurement end (voiceband).

Central Office (CO) Usually a local switching system. In more general terms, any network switching system. Sometimes means a telephone company building which houses a switching system. Can also mean equipment (such as transmission system equipment) that such a building may contain.

Central Processing Unit (CPU) The "brains" of the computer. It accepts data from outside devices, processes them, and delivers them to storage. It contains the arithmetic and logic unit and the control unit.

channel A transmission path between two points. May refer to a one-way path. When paths in the two directions of transmission are always associated, refers to a two-way path.

This is usually the smallest subdivision of a transmission system by which a single type of communications service (i.e., voice or data) is provided. In channelized testing, a channel is a single 64-kbps signal.

Channel bank Signal transmission equipment used to combine channels using either time division or frequency division multiplexing.

Channel Service Unit (CSU) A unit located on the customer's site that terminates a channel. Used with the customer's logic and timing recovery circuitry.

channelized testing The isolation and testing of only a particular data path out of many such paths included in a conglomerate data signal.

checksum The sum of a group of data items associated with the group for checking purposes.

circuit A communications path between two or more points. See **channel**.

clock An oscillator-generated signal that provides a timing reference for a transmission link; used to control the timing of functions such as sampling interval, signaling rate and duration of signal elements.

codes See **Network Control Codes**.

collection hub A collection point for data from a number of end offices. Data is combined into a single bit stream for transmission back to the hub office. A collection hub does not have test capability, MJUs, or analog extension equipment.

combining Ability of multipoint junction units (MJUs) to interlace the primary and secondary channel information.

Common Channel Signaling (CCS) A signaling method in which a single channel conveys, by labeled messages, signaling information. This information relates to several circuits and is useful for network management.

Communications Test System (CTS) The Hekimian 3700-series test equipment for analog and channelized testing.

control signals Signals in byte format used for synchronization, status, and remote testing.

CRC-6 block error count The total number of CRC-6 block errors that occur during a timed test interval. (Applies to DS1 signals with ESF framing format.)

CRC-6 error A error which occurs when the received CRC-6 pattern does not match the computed pattern. This is available only in the ESF mode of a DS1 signal.

cross-connect Hardware that interconnects multiplexers with line terminating equipment and other multiplexers. Access to signals is often available through jacks associated with a testboard located near the cross-connect.

crosstalk Interference in a communications channel caused by a signal traveling in an adjacent channel.

Current Ratio The ratio of errors measured during the last ten seconds. Applies to bit error and bipolar violation ratios.

Cyclic Redundancy Check (CRC) A method of checking data integrity that uses a constant divisor to divide the numeric binary value of a block or frame of data.

Data Communications Equipment (DCE) The interfacing equipment sometimes required to couple the data terminal equipment (DTE) into a transmission circuit or channel. Also couples a transmission circuit or channel to the DTE. Also known as Data Circuit-Terminating Equipment.

data port The point of access to a computer that uses trunks or lines for sending/receiving data.

Data Service Unit (DSU) A device that transmits digital data on transmission facilities. Typically, it interfaces the customer's test equipment (DTE) to a line connecting a data port channel unit. This allows digital communications without a modem. If the DTE lacks complete digital line interface capability, it may be collocated with the CSU on the customer's site. It may also be a stand-alone unit.

Data Terminal Equipment (DTE) Equipment consisting of digital end instruments. Converts user information into data signals for transmission. Also reconverts received data signals into user information.

DATP table The system configuration chart for the Model 3210 and 3216 Access Control Shelves in the MTAU, Mini-MTAU, DTAU, DTAU+, Mini-DTAU, and Micro-DTAU.

DATS maintenance The process of setting up, revising, and checking the configuration of Hekimian supplied access and test equipment (DTAS and MTAU).

dBm Decibel (dB) referred to 1 milliwatt. Used as a measure of absolute power values. Zero dBm equals one milliwatt.

dB_{rn} Decibels above reference noise, where 0 dB_{rn} equals -90 dBm.

DCS Concentrator A device used to collect the test access digroups (TADs) of many digital cross-connect systems (DCSs). Once they have been collected in one location, the TADs can then use a shared pool of test equipment. DCS concentrators thereby reduce the amount of test equipment (and associated cost) needed to support the DCS frames.

DDS Test Unit (DTU) The Hekimian Model 6302 test set that provides bidirectional DS1 and DS0A/DS0B interfaces. T1 and substrate access and testing require these interfaces.

demodulation The process of restoring a signal to its original form at the receiving end of a transmission system.

dialback number The phone number associated with the automatic error reporting function of a DTAU, MTAU, or similar unit.

digital channel A transmission channel that carries signals in digital form.

Digital Cross-connect System (DCS) A sophisticated digital switch. It can switch an entire T1 line, a group of channels, or one specific channel.

Digital Data System (DDS) A system that provides private line, point-to-point and multipoint, duplex data transmission.

Digital Remote Test Unit (DRTU) The Hekimian Model 6700 test set that provides complete monitoring and testing capabilities for digital circuits (DDS, FT1, Switched 56, PCM, and DS1). This test set also supplies an interface to Hekimian's PVS Analyzer (Model 6351 and Model 6352).

Digital Serving Area (DSA) The combined geographical serving areas of a set of DDS serving offices. The appropriate tariff(s) specifies this area. The DDS office serving areas that make up a DSA are not necessarily continuous. Also, a DSA may overlap state and associated company boundaries. A typical DSA encompasses one urban area of a single associated company.

digital signal A signal that has a limited number of discrete states before transmission.

digital system cross-connect (DSX) An internal interface that acts as a central point for cross-connecting, rearranging, patching, and testing digital equipment and facilities.

Digital Test Access System (DTAS) Hekimian's family of digital access and test equipment.

Digital Test Access Unit Plus (DTAU+) A subset of digital access and test equipment included in Hekimian's DTAS product line. This equipment provides hitless access to T1 lines in both the monitor and split modes.

digroup (digital group) A basic group of PCM channels assembled by time division multiplexing (TDM). Usually derived from 1.544-Mbps PCM-multiplex equipment.

DS0 Digital signal at the 0 level. A BPNRZ signal at the 64-kbps rate.

DS0-DP Digital Signal at 0-level Data Port channel unit. A plug-in circuit pack that recovers a DS0 signal for further connections. Its input and output signals are at 64 kbps.

DS0A A DS0 signal that carries data for only one customer. For subrates, the customer data is byte-stuffed as necessary to obtain the DS0 signal level. Only DS0 data signals appear at the DSX0A.

DS0B A DS0 signal that is the same as a DS0A signal when carrying 56-kbps customer data. However, this signal can also carry data for several subrate customers. For subrates, successive bytes carry data for different customers so each customer-generated bit appears only once in the DS0B signal. DS0B signals appear at the DSX0B.

DS1 Digital Signal at level 1. A BPRZ T1 signal at the 1.544-Mbps rate. The channel data format on the 24-channel line.

DS1 framing errors Frame synchronization bit errors detected by the Model 6302 DTU in either terminal framing (F_t) or signaling framing (F_s) bits.

DS1 Performance Unit (DPU) The Hekimian Model 6301 test set that provides complete in-service monitoring. This test set also provides out-of-service testing of DS1 signals.

DS1 Signal Access Unit (DSAU) A plug-in circuit pack used in DDS hub offices. This unit provides full duplex access to a DS1 signal. This facilitates centralized maintenance and testing.

DS1 Test Access Unit (DTAU) A subset of digital access and test equipment included in Hekimian's DTAS product line. This equipment provides split and hitless monitor access to T1 lines for maintenance and testing.

DS3 Digital signal at level 3. Consists of 28 DS1 signals at a 44.736 Mbps rate.

DS3 Test Unit The Hekimian Model 6305 test set that provides complete monitoring and testing capabilities for in-service and out-of-service DS3 circuits.

Dual-Tone Multifrequency (DTMF) Signaling that uses a simultaneous combination of a lower and higher group of frequencies to represent each digit or character. The lower tones are 697, 770, 852, and 941 Hz, and the higher tones are 1209, 1336, 1477, 1633 Hz.

duplex A facility which permits transmission in both directions simultaneously. Also called **full-duplex**.

duty cycle The percent of a single pulse period (for a "1") during which the voltage is nonzero. The ratio between actual pulse width and the total available time slot.

echo suppressor A device that detects speech signals transmitted in either direction on a four-wire circuit. This device suppresses echoes by introducing loss in the opposite direction of speech transmission.

EIA Interface One of a set of signal characteristics set up by the Electronic Industries Association for standardization. These characteristics include time, duration, voltage, and current.

elapsed bits The number of bits that have elapsed since the beginning of a timed test.

elapsed time The time that has elapsed since the beginning of a timed test interval.

Enhanced Monitor/Matrix Unit (EM/MU) An optional component in either a DTAU or Mini-DTAU. This unit performs extensive scanned monitoring of T1 lines.

equalizer A network which corrects a circuit's transmission characteristics. It may correct for gain-slope (non-linear frequency response) or for delay distortion.

error event (DS3) A second with one or more frame format coding violation events and no OOF or AIS events.

(DS1-SF) A second with the occurrence of a bipolar violation, bit error, framing bit error, frame slip, loss of signal, loss of frame synchronization, or loss of pattern synchronization.

(DS1-ESF) A second with the occurrence of a bipolar violation, bit error, CRC-6 block error, frame slip, loss of signal, loss of frame synchronization, or loss of pattern synchronization.

error free second A second that does not contain any error events. These seconds are calculated as $100 \times [1 - \text{errored seconds/measurement period}]$. Circuit quality is usually expressed in percentage of EFS.

errored second Any second which contains one (or more) error events.

excessive zeros Sixteen or more zeros in a row.

extended superframe (ESF) A DS1 framing format in which the 193rd bit of the bit stream is a shared bit. This means there are 24 framing bits. The 193rd bit follows a 24-frame sequence instead of 12 (superframe). This is the same as using an 8k-bit data channel to frame the signal and identify which frames carry signaling information.

far-end block error (FEBE) Status information sent from the near end terminal to the far end terminal to indicate the presence of a framing error, parity error, OOF or AIS event at the far end terminal.

foreign exchange A circuit between a customer's main station or private branch exchange and a central office. This circuit is different than the one that normally serves the exchange area in which the customer is located.

format errors Any deviations from the prescribed format of the signal. This includes bipolar violations, low average pulse density, or loss of synchronization.

four-wire circuit (4W) A circuit which uses two electrically separated paths to carry data signals. One path is used for each direction.

Fractional T1 Fractional T1 technology combines several individual channels on a T1 and uses them as a single channel. This action provides channels of a greater bandwidth (multiples of 64 or 56 kbps) than the typical 64-kbps channel.

frame A cyclic set of consecutive time slots in which the relative position of each time slot can be identified.

frame error (DS1) A frame synchronization bit error which occurs in either a terminal framing (F_T) bit or signaling framing (F_S) bit of the superframed format. (DS3) A frame synchronization bit error detected in either the multiframe alignment signal (M-bit) or frame alignment signal (F-bit).

frame slip The deletion or duplication of a frame of data. You detect this by the following event sequence:

- 1) Two bit errors occur in four consecutive frame synchronization bits.
- 2) Before declaring an out-of-frame condition, you examine the following 12 bits for correct sequence and bit delay.
- 3) If the framing bits are in the correct framing pattern sequence, you have a frame slip. The receiver returns to the new frame alignment. No out-of-frame condition occurs.

frame sync loss In SF, once in sync, two of the last five framing bits (F_t) in error. In ESF, once in sync, two of the last five framing pattern sequence bits in error.

framing A procedure for controlling errors. Consists of inserting bits so the receiver can identify the time slots allocated to each subchannel.

framing bit A bit introduced into a bit stream that identifies where one frame ends and the next one begins. This bit helps separate the characters at the receiving end of a transmission.

framing bit error (FBE) In SF, the receipt of a terminal frame bit (F_t) or the signal frame bit (F_s) is different than expected. In ESF, the receipt of a framing pattern sequence bit is different than expected.

framing bit error ratio The number of framing bits in error divided by the total number of framing bits. This computation does not include any second where there is LOS, SES, OOF, or AIS condition.

Frequency Division Multiplexing (FDM) The process of combining a number of analog signals onto a single transmission facility by an orderly assignment of frequency bands.

full-duplex A transmission mode in which information can travel in both directions at the same time.

half-duplex A transmission mode which permits transmission in both directions, but only one direction at a time.

Hierarchical Storage Controller (HSC) An off-board disk and tape controller for clustered VAX computers.

High Capacity Digital Services (HiCap) Bell service that uses DS1 digital facilities to provide communications channels to BOC customers at 1.544 Mbps.

High Density Bipolar Three (HDB3) A line coding format that ensures a minimum ones density by substituting a string of four zeros with a unique pattern of BPVs and a one.

hit Any disruption of service that lasts for less than one second. A longer disruption is called an **outage**.

home To connect an office to a higher class office by means of a final trunk group. Offices do not always home on the next higher class office.

Idle code A repetitive pattern to identify an idle channel (typically, 0111 1111).

inband A signaling method that sends signals over the same transmission line or circuit as the user's communication. These signals are also in the same frequency band as that provided for the user.

jitter Spurious timing variations in digital pulses over a T1 line.

Keep Alive signal (KA) An unframed all ones pattern sent in the nontest direction during circuit testing.

Link Problem Determination Aid (LPDA) IBM LPDA is a component of **NETVIEW**. Requires IBM modems or IBM DSU (a few compatibles are available).

line From a switching viewpoint, the loop, station equipment, and central office associated equipment assigned to a customer. From a transmission viewpoint, the transmission path between a customer's station equipment and a switching system.

Local Access and Transport Area (LATA) The geographical area served by a single local telephone company.

logic errors Any change in an originally transmitted signal (for example, a bit change from a 1 to a 0). These errors can be caused by cross-talk, jitter, slips, hardware, software, or human errors.

logical A name you can use in place of or as part of a file specification. These names are easier to remember and type than the full file specification.

long-haul facilities Facilities used for the inter-DSA portion of an interstate circuit (typically beyond 50 miles).

Longitudinal Redundancy Check (LRC) A method to make sure data is received correctly. Consists of performing parity checks across the data message.

long-term testing A type of circuit testing in which a tester's terminal may be logged out of an operations support system without ending the test. The circuit test can be left to run for any amount of time, and the results retrieved at a later date.

Loop Access Test System (LATS) A relay connection matrix that provides access to individual customer four-wire local loops and/or to DS0 (64 kbps) circuits. The matrix is only at DDS hub offices.

loop signaling A method of signaling over dc circuit paths. This method uses the metallic loop formed by the line or trunk conductors and terminating circuits.

looping A test procedure in which the received signal returns to its source.

loss of signal (LOS) The absence of pulses lasting for one millisecond or more.

macro A previously recorded, or "programmed," set of instructions that automatically execute one after another. The main purpose of macros is to provide automatic test procedures.

mapping In network operations, the logical association of one set of values, such as addresses on one network, with quantities or values of another set such as devices on another network. Includes name-address mapping, internetwork-route mapping and protocol-to-protocol mapping.

master/slave testing A test method that allows end-to-end testing without a second operator. A test set (master) at one end controls a test set (slave) at the other end of the line under test.

modulation The process by which the amplitude, frequency, or phase of a carrier signal varies with the same of the characteristics of an information signal.

monitor access testing Nonintrusive circuit testing performed without splitting the circuit to put the test equipment in-line with the tested signal.

Monitor/Matrix Unit (M/MU) An optional component in either a DTAU or Mini-DTAU. It performs basic scanned monitoring of T1 lines.

multiframe A set of consecutive frames in which the relative position of each frame can be identified.

multifrequency signaling An inband address signaling method between offices. In this method, 10 decimal digits and 5 auxiliary signals are represented by selecting two frequencies out of the following group: 700, 900, 1100, 1300, 1500, and 1700 Hz.

multiplexing The compressing of a number of signals into a single composite signal.

multipoint circuit A customer circuit providing simultaneous transmission among more than two end points. Usually one end point is the control point.

Multipoint Junction Unit (MJU) A unit that links three or more segments of a multipoint circuit at a DDS hub office.

Network Control Codes, see page G-22.

off-hook Station switchhook contacts closed, or whatever supervision condition shows the in-use or request-for-service state.

Office Channel Unit (OCU) A terminal in the central office or DDS serving end office that provides DDS circuit access.

on-hook Station switchhook contacts open, or whatever supervision condition is indicative of the equipment-idle state.

opcode The operation code is the command keyword of a machine instruction.

outage Any disruption of service that lasts for more than one second. (A shorter disruption is called a **hit**.)

overhead All control, routing, and error-checking characters in addition to user-transmitted data; includes information that carries network-status or operational

instructions, network routing information, and retransmission of user-data messages that are received in error.

Packet Assembler/Disassembler (PA/D) A device that accepts characters from a terminal or host computer. It then puts the characters into packets that a packet switching network can handle. It also accepts packets from the network, then disassembles them into character streams that the terminal or host can handle.

parity check A process for detecting data bits that changed during transmission.

percent error free seconds The percentage of elapsed test seconds that do not contain errors.

performance monitoring The collection of data, on either a part-time or full-time basis, so that the overall efficiency of a circuit may be determined.

Point Of Presence (POP) The physical access location within a LATA of a long-distance and/or inter-LATA common carrier. The point to which the local telephone company terminates subscriber's circuits for long-distance dial-up or leased-line communications.

point-to-point A circuit that interconnects two points directly, where there are generally no intermediate processing nodes, computers or branched circuits, although there could be switching facilities; a type of connection such as a phone-line circuit that links two, and only two, logical entities.

Polar Return-to-Zero A polar signal with a 50 percent duty cycle.

polar A signal stream in which all one bits are the same voltage polarity (either positive or negative). All zero bits are the opposite polarity from the one bits.

portmap See Test Resource Status display.

private line A customer leased circuit, not interconnected with the public switched telephone network, for the customer's exclusive use. The private line provides transmission of voice, teletypewriter, data, television, etc.

program circuit A voice-frequency circuit which has been equalized to handle a wider range of frequencies than what ordinary speech signals require.

protocol Formal set of rules governing the format, timing, sequencing and error control of exchanged messages on a data network; may be oriented toward data transfer over an interface, between two logical units directly connected, or on an end-to-end basis between two users over a large and complex network.

Protocol Vital Signs™ (PVST™) A systematic method of analysis and display of protocol operational parameters to aid in determining the cause of performance degradation.

Public Switched Digital Service (PSDS) A service that provides alternate voice and data on a 2-wire user loop.

Pulse Code Modulation (PCM) The process that samples, quantizes, and codes the modulating analog signal into digital bit stream.

quantization The process that divides the continuous range of values of a signal into nonoverlapping (but not necessarily equal) subranges. It then assigns a discrete value of the output to each subrange. Whenever the signal value falls within a given subrange, the output has the corresponding discrete value.

Quasi-Random Signal Source (QRSS) A specific BERT pattern that can be injected into a channel and sent to a device. Used to test a device's ability to receive a pattern correctly without any bit errors.

Quick Test Automatic test procedures for testing DS1 or DDS circuits in REACT 2000.

Random Access Memory (RAM) A solid-state memory device used for transient memory storage. Allows you to enter and retrieve information from any storage position.

Read-Only Memory (ROM) A solid-state memory device which has information permanently written into the memory during manufacture.

REACT 2000 Hekimian's Operations Support System (OSS) for provisioning, monitoring, testing, and administering telecommunications networks.

real time A transmission or data processing operating mode by which data is entered in an interactive session; pertaining to an application whereby response to input is fast enough to affect subsequent input such as a process-control system; describing processing in which the results are used to influence an ongoing process.

reboot To restart the computer from power on.

red alarm A red alarm is caused by a locally detected facility failure. A red alarm sends a yellow alarm back towards the transmit end of the circuit.

Relay Access Unit This unit performs metallic circuit accesses in DTAU or Mini-DTAU.

remote alarm See **yellow alarm**.

restore To reload information onto a disk from a backup tape.

resynchronization (framing) A signal correction performed because two frame synchronization errors were detected. These errors were in four consecutive frame synchronization bits, and there was no frame slip. As a result, REACT reframes the signal and resynchronizes the pattern.

resynchronization (pattern) A signal correction performed due to a disruptive or out-of-service test with a known pattern, more than 307 bit errors occurred in a 10-msec interval. (This corresponds to a 1 in 50 error rate.) When this happens, REACT shows a pattern synchronization loss and resynchronizes both the framing and the pattern.

ringing The process of alerting the called party by the application of an intermittent ac signal (typically 20 Hz) to the appropriate line. When you apply the ringing signal to the

called line, you send an audible ringback tone to the calling telephone to show that ringing is occurring.

saveset The name of a file for a particular backup. A specially constructed file used for storing backup files.

secondary channel The secondary channel is a low speed data channel on a DDS circuit that is combined with the primary DDS channel.

Service Control Point (SCP) The database for SS#7 tables.

Service Switching Point (SSP) The end office switch, typically 5E or DMS 100.

severely errored second (SES) (DS1) A second which has an equivalent error ratio greater than 1-in-1,000. In SF, a second with one or more LOSs or frame sync losses, six or more framing bit errors, or 1,544 or more BPVs. In ESF, a second with one or more LOSs or frame sync losses, 320 or more CRC-6 errors, or 1,544 or more BPVs. On unframed circuits, a circuit with one or more LOSs, or 1,544 or more BPVs.

short-haul facilities Facilities that stay within the DSA. Can provide intrastate or interstate services with distances typically less than 50 miles.

signal loss A received signal that has 32 or more consecutive zeros. Or, the signal is of a received level less than 32 dB below the DSX level.

signal status The absence or presence of a signal.

Signaling Transfer Point (STP) A packet switch optimized for SS#7 message handling.

single-ended testing A test equipment configuration used for cooperative testing between test units at two points on the circuit.

single-frequency (SF) signaling A method of conveying dial-pulse and supervision signals from one end of a trunk or line to the other. This method uses the presence or absence of a single specified frequency (usually 2600 Hz).

slip A defect in timing that causes a single bit or a sequence of bits to be omitted or duplicated.

Smartjack An interface connector which provides T1 loopbacks at the network interface. Used in place of or along with channel service units at the customer's site.

SMARTEST™ A REACT 2000 option that enables testers to schedule automatic, unattended testing.

split-access testing Testing in either a loopback or single-end configuration that disrupts the signal being tested.

SS#7 Packet switching network protocol used to provide signaling to establish and disconnect calls (and other related services including 800 translation, and credit card verification).

stand-alone A backup mode used to make backup copies of the operating system.

straightaway test A test procedure in which one point on the circuit sends a test signal to a receiver at a different point.

streaming Nonstop transmission of signals down a data line, from a defective piece of equipment, such as a modem. Streaming equipment ties up a multipoint circuit with false signals and prevents other equipment from using the circuit.

stress test A type of data circuit testing used to determine a circuit's ability to efficiently carry data signals with a low "ones density."

Subrate Digital Multiplexer A unit in the hub office, that combines several data streams at or below some basic rate (2.4, 4.8, 9.6, or 56 kbps) into a single 64-kbps (DS0B) signal.

subrate frame slip A slip that occurs when a subrate framing bit is lost or duplicated, but the framing pattern integrity is otherwise maintained.

subrate framing errors Incorrect framing bits from the DS0B signal under test.

Switched 56 A data circuit that operates at 56 kbps over switched virtual circuits.

Switched Access Remote Test System (SARTS) An AT&T operations support system that permits remote testing of end offices. The SARTS system communicates with these end offices through the public data packet network.

Switched Maintenance Access System (SMAS) AT&T system that provides remote circuit testing for intermediate and end offices. It allows a tester to access and test a circuit without the aid of another tester in a distant office.

synchronization lost seconds Seconds of lost DS1 synchronization.

synchronous Data communications in which characters or bits are sent at a fixed rate, with the transmitting and receiving devices synchronized; eliminates the need for start and stop bits basic to asynchronous transmission and significantly increases data throughput rates.

synchronous error measurement A measurement that, after an error occurs, measures any further errors in that synchronous second. After one second from the original event, the second is marked as a synchronous errored second, and a new measurement begins.

system administration A REACT function that deals with the configuration and operation of the test system.

system controller node The location of the REACT 2000 system controller equipment and the system console. The system console node allows maintenance of the REACT 2000 software. Maintenance tasks include installing, updating, modifying, and backing up the REACT software and circuit databases.

system management A REACT function that deals with the computer setup. It involves setting up and maintaining the configuration of the computer.

T1 A digital transmission channel that carries data at the 1.544-Mbps rate (DS1 level).

T1 Digital Multiplexer (T1DM) A unit that multiplexes 23 channels of 64-kbps signals into one 1.544-Mbps signal. The remaining time slot (channel 24) is used by the multiplexer for sync, alarm, and overhead data.

test node The Hekimian and third party equipment located at a remote site. This equipment accesses and tests communication systems.

terminal server An electronic device containing communication ports that may be configured in various ways in order to serve various types of devices. Normally used to obtain increased routing efficiency among such devices as display terminals, modems, and computers.

Test Progress Tone (TPT) A short tone sent out by a 105-type responder that the 3700-series CTSs detect.

test resource nodes Circuit access points that contain circuit access equipment, test equipment, and system controller interface equipment. During circuit testing, testers select appropriate test resources. A Test Resource Status display lists these resources.

tester workstations Workstations equipped with video terminals that are either directly or indirectly linked to the system controller equipment through modems, line concentrators, or controllers.

threshold A numerical count under or over which a circuit performance event is to be reported.

time division multiplexing (TDM) The process of combining a number of digital signals into a single digital stream by an orderly assignment of time slots.

tip and ring conductors The two conductors associated with a two-wire cable pair.

TK50 A 95-megabyte streaming cartridge tape drive used on MicroVAX computers.

Transmission Level Point (TLP) A specification, in dB, of the relative level at a particular point in a transmission system. This is referenced to a zero transmission level point.

trunk A dedicated circuit that interconnects two switching centers or central offices.

TS05 The only 9-track tape drive now available for the MicroVAX II computer. Also used for the VAX 8200/8300.

TU80 One of three 9-track tape drives now available for the VAX 8200/8300 computer. Also available are TS05 and TU81.

TU81 One of three 9-track tape drives now available for the VAX 8200/8300 computer. Also available are TS05 and TU80.

two-wire circuit (2W) A circuit that carries data signals in both directions on the same path.

unipolar A signal stream in which all one bits are the same voltage polarity. 0 bits normally are zero volts.

unipolar return-to-zero A unipolar signal with a 50 percent duty cycle.

User-Defined Macro A REACT 2000 option allowing a tester to record the steps taken to test a circuit, and to later play back those steps automatically to test another circuit of the same type.

VAX (Virtual Address eXtension.) The family of DEC computers that host Hekimian's REACT 2000 Operations Support System.

VMS (Virtual Memory System) The DEC computer operating system for Hekimian's REACT 2000 OSS.

voiceband A transmission channel with a nominal 4-kHz bandwidth suitable for voice transmission.

volume An individual cartridge or reel of tape used in backup operations. Often the data does not fit on one volume. In that case, multiple cartridges or reels are used.

X.25 International standard protocol for transmission of data packets over switched or permanent virtual channels.

yellow alarm A alarm received at the transmit end of the circuit to indicate that a failure has occurred in the receive direction.

NAME	NETWORK CONTROL CODES
CSU Latching Loopback	Network control Code S01 10001.
Channel Loopback	Network control code S0101000.
DS0 DP Latching Loopback	Network control code S0000101.
DS0 Out of Sync	Network control code S1001100.
DSU Loopback	Network control code S0101100.
Far-End Voice (FEV)	Network control code S1011010.
Idle code	Network control code S1111110.
Loopback Enable	Network control code S1010110.
Loopback Select Code	Network control code SYYYYYYY1. The Y's denote the 6-bit code identifying the type of loopback device.
MAP (DCS)	Network control code S1010001.
MAP0 (LBE mapping)	Network control code S0010011.
MAP1 (LBE mapping)	Network control code S1101101.
MAPFEV	Nonsecondary channel mode, network control code S1111010.
MJU Alert	Network control code S1110010.
MJU Block	Network control code S0001010.
MJU Block Release.	Network control code S1111000.
MJU Branch	Network control code S0101xx1. The xx is the branch number (00=1, 01=2, 10=3, 11=4).
MJU Hub ID	Network control code Sxxxxxx1. The x's are the hub ID. The MJU returns this as two octal numbers.
MJU Loopback	Network control code S1010001.
MUX Out of Sync	Network control code S0011010.
OCU Latching Loopback	Network control code S1010101.
OCU Loopback	Network control code S0101010.
Test Alert	Network control code S1101100.
Test Code	Network control code S0011100.
Transition In Progress	Network control code S0111010.
Unassigned MUX Channel	Network control code S0011000 (data) or S0000010 (data/voice).

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Problem Description

Describe the problem. (Also describe how to reproduce it, your diagnosis, and suggested correction.) If the problem is software-related, please have the System Administrator sign: _____

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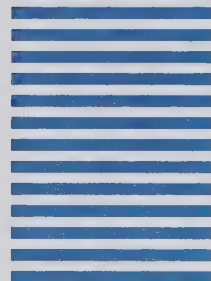
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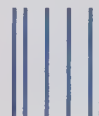
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